HiSoft BASIC 2 for
ST/STE/TT Computers

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HiSoft
High Quality Software

HiSoft BASIC
version 2

Technical Reference

more software for your Atari ST/STE/TT from

HiSoft
High Quality Software

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HiSoft BASIC 2 for the Atari ST/STE/TT

By HiSoft

Program: designed and programmed by HiSoft.

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High Quality Software

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Chapter 1
Command Reference

This chapter gives a detailed description of each and every HiSoft BASIC statement and function.

It is arranged as follows:

• Syntax

This shows the allowable forms of the statement or function.

Parameters are denoted in *italics* and optional items are enclosed in square brackets [ ].

• Effect

Details a summary of the actions of the statement or function.

• Comments

This describes the actions in much greater detail, where this is useful.

• See

Any entries under this heading will point you towards other commands that are related in meaning to this command. It will normally be useful to consult these other entries for background information.

• Example

Shows one or more examples of the statement or function in use.

ABS function

• Syntax

ABS(*numeric_expression*)

• Effect

This function returns the absolute value of the *numeric_expression*

• Comments

The absolute value function returns the unsigned value of the *numeric_expression*. The absolute values of both -1 and 1 is 1. The type of the result is the same as the type of *numeric_expression*.

• See

SGN.

• Example

```
PRINT ABS(6*(7)), ABS(6*(-7))
```

Result:

```
42   42
```


ASC function

• Syntax

ASC(*string_expression*)

• Effect

This function returns a numeric value that is the ASCII code for the first character of the *string_expression*.

• Comments

If the string passed is a null-string, an `Illegal function call` error is given. The result is an integer.

• See

CHR$.

• Example

```
X$="FORTY-TWO"
PRINT ASC(X$)          'Prints ASCII code for "F"
```

Result:

```
70
```

ATN function

• Syntax

ATN(*numeric_expression*)

• Effect

This function returns the arctangent of the *numeric_expression*, or the angle whose tangent is the *numeric_expression*.

• Comments

The result is returned in radians, in the range of $-\pi/2$ to $\pi/2$ radians.

The *numeric_expression* can be of any numeric type. ATN is single precision by default; if the numeric value is double precision, ATN returns a double precision value.

• See

SIN, TAN, COS.

• Example

```
PRINT 4*ATN(1);4*ATN(1#)
```

Result:

```
 3.141593    3.141592653589794
```


BAR statement

• Syntax

BAR *x_start*,*y_start*,*width*,*height*

• Effect

An outlined box is drawn in the current output window.

• Comments

The same drawing attributes as CIRCLE are used, i.e. the current fill colour is used for the outline, and together with the current index and style it is used for the interior.

x_start and *y_start* specify the top-left corner of the bar relative to the current output window.

This call uses the GEMVDI v_bar graphics primitive.

• See

COLOR, LINEF, v_bar VDI command.

• Example

```
COLOR 1,1,1,2
BAR 100,50,50,20
```

BEEP statement

• Syntax

BEEP

• Effect

The monitor speaker will beep.

• Comments

BEEP uses the ASCII bell character; the same effect can be attained by using PRINT CHR$(7);.

• See

SOUND, WAVE.

• Example

```
FOR I=1 TO 10
    BEEP
NEXT I
```

This loop produces a single beep ten times the length of a one BEEP.

BIN$ function

• Syntax

BIN$(*numeric_expression*)

• Effect

This function returns a string that represents the binary value of the *numeric_expression*. If the expression is an integer then the resulting string will be from 1 to 16 characters in length, but if it the expression is a long integer the result can be up to 32 characters long.

• Comments

The *numeric_expression* is rounded before being evaluated by HEX$. If the parameter is an integer then the resulting string will be from 1 to 4 characters in length, and if it is a long integer then the result may be up to 8 characters in length.

• See

OCT$, HEX$, *User Manual : Concepts* chapter.

• Example

```
PRINT BIN$(8);
```

Result:

1000

BLOAD statement

• Syntax

BLOAD *filename,address*

or

BLOAD *#channel,address,byte_count*

• Effect

This statement loads a binary file into the buffer specified, or reads an arbitrary number of bytes from the given channel.

• Comments

The *filename* is a string expression following the standard GEMDOS conventions. The *address* is a long integer.

The buffer address is the responsibility of the user. BLOAD does not check if the address given is a safe address in RAM.

In the second form the channel should be opened using the OPEN statement and byte_count gives the number of bytes to read. This form of BLOAD is similar to the INPUT$ except that it lets you read into an array, or another address, instead of a string.

• See

BSAVE, INPUT$, GET.

• Example

```
BLOAD "PICTURE.DMP",SPEEKL(&H44E)
```

This line loads a binary file directly into the video-RAM (which for the standard ST resolutions is 32000 bytes in length). &H44E is the system variable where the address of the screen is kept. SPEEKL is necessary, as the address of the video-RAM is 32 bits long and the system variable is in supervisor memory.

```
OPEN "PICTURE.NEO" FOR INPUT AS #1
DIM header(64)
BLOAD #1,VARPTR(header(0)),128
BLOAD #1,SPEEKL(&H44E),32000
CLOSE #1
```

This example will load a NEOchrome file directly into the video RAM for ST low resolution , reading the Neochrome file header into the array header(). The LOADSCR.BAS program is another example of its use.

BSAVE statement

• Syntax

BSAVE *filename,address,length*

or

BSAVE *#channel,address,length*

• Effect

This statement saves the contents of the specified buffer to the output device specified in *filename* or *#channel*.

• Comments

It is possible, though not necessarily useful, to BSAVE to the parallel or serial ports. Both the address as well as the length of the buffer are long integers. The *filename* must follow the GEMDOS conventions; alternatively you can output to a file that is already opened.

• Example

```
BSAVE "PICTURE.DMP",PEEK(&H44E&),32000
```

This line saves the entire ST video RAM to a disk file named PICTURE.DMP.

```
DIM a%(100),b%(100)
...
OPEN "ARRAYS.DAT" FOR OUTPUT AS #1
BSAVE #1,VARPTR(a%(0)),101*2 '101 elements of 2 bytes each
BSAVE #1,VARPTR(b%(0)),101*2
CLOSE #1
```

This program fragment saves the entire contents of the arrays a%() and b%() to the file ARRAYS.DAT. Note that you can only save numeric arrays in this manner.

• See

BLOAD, PRINT#, WRITE.

CALL statement

• Syntax

`[CALL] sub_program_name [(parameter [,parameter]…)]`

• Effect

Calls a sub-program defined using SUB...END SUB or a library routine.

• Comments

sub_program_name is the name of the sub-program being called. There must be the same number of parameters as in the sub-program's declaration.

Further information on sub-programs can be found in the *Concepts* chapter of the *User Manual*.

The keyword CALL can always be omitted if the sub-program has parameters and if it is not the first statement of a multi-statement line; this is to avoid conflicts with label declarations which are also identifiers followed by a colon. If CALL is omitted the brackets round the parameters *must* be omitted.

Array parameters must be passed array names followed by () in CALL statements and string parameters must be passed strings. However different numeric types will be converted to the type required by the sub-program.

Parameters are passed by reference if they consist of just a variable of the same type as in the declaration of the sub-program and the VAL or BYVAL keywords were not specified for the parameter when the sub-program was defined. Array elements may be passed as variable parameters.

You can pass a variable by value when it would otherwise be passed by reference simply by enclosing the parameter in parentheses.

• See

SUB, FUNCTION.

• Examples

```
QuickSort MyArray(),100
CALL QuickSort(MyArray(),100)    ' these are equivalent
QuickSort(MyArray(),100)         ' syntax error because
                                 ' of brackets
call SKIP_ONE:SKIP_ONE  'call required for first call
FRED  X          ' call by reference
FRED (X)         ' call by value
```


CALL LOC statement

• Syntax

`CALL LOC address [,parameter]…`

• Effect

Call a machine-code routine, with the option of passing parameters.

• Comments

This is directly equivalent to the ST BASIC CALL statement. Unfortunately we had to change the syntax to avoid confusion between machine-code and sub-program CALL statements.

The machine-code at *address* is executed, and these parameters can be found on the stack:

(a7)	long	return address
4(a7)	word	number of parameters
6(a7)	long	pointer to parameter block

The parameter block consists of a sequence of longs, one for each parameter passed. In the case of numeric parameters this is the rounded long-integer value of the parameter, but in the case of string parameters this is a pointer to the string, null terminated.

The machine-code can return to the BASIC program by executing a RTS statement. All registers except A7 may be destroyed.

In general it is better to access machine code by linking with the machine code routine or writing your own HiSoft BASIC library.

• See

Appendix F: Linking, Writing your own libraries.

• Example

```
DIM spare%(100)
BLOAD "CALCPI.PRG",VARPTR(spare%(0))
calcpi&=VARPTR(spare%(0))+28     '+28 to skip header
CALL LOC calcpi&,100,"PI"
```

CALLS statement

• Syntax

CALL *sub_program_variable*

• Effect

Calls a sub-program indirectly using a variable as a pointer for it.

• Comments

sub_program_variable must have been initialised using the VARPTRS function to point to a sub-program. the sub-progam must not have any parameters.

Caution: this is for advanced programmers only. Incorrect use of CALLS can wreak havoc on a running program or its memory area.

• See

VARPTRS, CALL.

• Exomple

```
read_char&=VARPTRS(char_from_disc)
DO
    CALLS read_char&
LOOP UNTIL no_more
.
.
SUB char_from_disc
IF EOF(2) THEN
    read_char&=VARPTRS(char_from_mem)
    CALLS read_char&
    EXIT SUB
ELSE
.
.
.
END SUB
```


CDBL function

• Syntox

CDBL(*numeric_expression*)

• Effect

This function converts the *numeric_expression* to a double precision number.

• Comments

The effect is identical to assigning the *numeric_expression* to a double precision variable and then using the double precision variable.

• See

MKD$, CINT, CLNG, CSNG.

• Example

```
PRINT ATN(1)          'single precision
PRINT CDBL(ATN(1))    'single extended to double
PRINT ATN(CDBL(1))    'double precision accuracy
```

Result:

```
 .7853982
 .7853981852531433
 .7853981633974485
```

CHAIN statement

• Syntax

`CHAIN` *`filename`*

• Effect

This statement loads and executes another program.

• Comments

`filename` should conform to GEMDOS specifications and be the name of an executable (i.e. double-clickable) program, including the extension. The program does not have to be a HiSoft BASIC compiled program.

The type of the program being `CHAIN`ed should be the same as the type of the program doing the `CHAIN`. For example trying to `CHAIN` a `.PRG` file from within a `.TOS` program will produce unpredictable and potentially disastrous results. `CHAIN` should not be used when compiling to memory.

All files are closed before the program is `CHAIN`ed.

• See

`RUN`, `Execute` (HiSoft GEM Toolbox routine).

• Example

```
DO
    INPUT "File to run";f$
    f$=f$+".PRG"
LOOP UNTIL FEXISTS(f$)
CHAIN f$
```


CHDIR statement

• Syntax

`CHDIR` *`pathname`*

• Effect

This statement changes the current directory.

• Comments

The *`pathname`* specified must conform to the GEMDOS conventions. This statement does not change the default drive, even if a drive is specified.

It is possible to use relative (as opposed to absolute) path names. If a directory `\ONE\TWO` exists and it is the current directory, `CHDIR ".."` will change the current directory to one hierarchic level higher (in this case `\ONE`).

It is also possible to `CHDIR` one level downwards. To switch from `\ONE` to `\ONE\TWO` requires `CHDIR "TWO"`; `CHDIR "\ONE\TWO"` is not necessary in this case.

• See

`CURDIR$`.

• Example

```
CHDIR "\HBASIC"  'an absolute path
CHDIR "SOURCE"   'this changes the directory
                 'to \HBASIC\SOURCE
```

CHR$ function

• Syntax

CHR$(*ASCII_code*)

• Effect

This function returns a one character string whose *ASCII_code* was passed as the parameter.

• Comments

CHR$ is usually used to produce characters which are not readily available from the keyboard. Common uses are sending a form feed (ASCII 12) to a printer or printing foreign characters on the screen. The *ASCII_code* is an integer.

• See

ASC, *User Manual : Concepts: Character Constants.*

• Example

```
LPRINT CHR$(12);     'sends a form feed to the printer
PRINT "Copyright ";CHR$(189);" Acme Programming"
```


CINT function

• Syntax

CINT(*numeric_expression*)

• Effect

This function converts the *numeric_expression* to an integer value by rounding its fractional part.

• Comments

If the *numeric_expression* is not in the range -32768 to 32767, an Overflow error is returned.

CINT differs from INT and FIX in that it produces an integer value by rounding. An example of the differences of the three functions can be found under INT.

This is equivalent to assigning the *numeric_expression* to an integer variable and then using that variable.

• See

INT, FIX, MKI$, CDBL, CSNG, CLNG.

• Example

```
PRINT CINT(1.5),
PRINT CINT(-1.5)
```

Result:

```
 2 -2
```

CIRCLE statement

• Syntax

`CIRCLE x_centre,y_centre,radius [,start_angle,end_angle]`

• Effect

Draws a circle or arc in the current window.

• Comments

If the optional angle parameters are omitted, the command draws a hollow circle in the current line colour (the third parameter in the `COLOR` statement). The angle parameters are expressed in degrees times 10, and are measured anti-clockwise starting on the right side. Solid circles and arcs can be drawn using the `PCIRCLE` command. All the parameters are integers.

The *`x_centre`* and *`y_centre`* are relative to the current window rather than the screen. `CIRCLE` ensures that the x radius and y radius are the same in pixels. As a result the graphic that is drawn will not appear circular in some resolutions (e.g. ST Medium) where the pixels are not square. To draw circles that look like circles but which will have different y-radii use the GEMVDI `v_circle` command.

• See

`ELLIPSE`, `PCIRCLE`, `BAR`, `v_circle`, `v_ellarc`, `v_ellipse` (VDI routines).

• Example

```
CIRCLE 200,100,75
CIRCLE 100,100,50,450,325
```


CLEAR statement

• Syntax

`CLEAR`

• Effect

This statement clears all variables and closes all channels.

• Comments

The following actions are taken by this command:

- All global numeric variables are reset to zero
- All global string variables are reset to a null string (i.e. `""`)
- All numeric arrays have their contents reset to zero
- All string arrays have their contents reset to a null string
- All files are closed

This is provided for compatibility with old dialects of BASIC. In general we recommend that you don't use it - just clear what you need to instead.

• Example

```
IF a$="ZERO" THEN CLEAR
```

CLOSE statement

• Syntax

CLOSE [[#]*channel_number*[,[#]*channel_number*]…]

• Effect

This statement terminates I/O to the specified file or device.

• Comments

CLOSE is the opposite of OPEN. The *channel_number* is the number specified in the OPEN statement for a particular file or device.

CLOSE without parameters closes all OPENed files and devices.

Once a file is CLOSEd, its channel number may be used to OPEN any unopened other file or device.

Closing a file or device that was opened for sequential output causes the final buffer to be written before closing.

If you have set SYSTAB+67 to a non-zero value when closing a sequential output file then a Ctrl-Z character (CHR$(26)) will be appended to it

CLOSEing a file that was opened for random access with automatically clear all the FIELDed variables that were associated with this file.

CLEAR, END/SYSTEM, RESET, STOP and RUN close all files and devices automatically.

• See

OPEN, SYSTAB.

• Example

```
CLOSE #1,#2
```


CLS statement

• Syntax

CLS

• Effect

Clears the screen and returns the cursor to the upper left corner.

• Comments

In a GEM program this will clear the current output window.

COLOR statement

• Syntax

```
COLOR text_colour[,fill colour][,line colour][,index]
    [,style]
```

• Effect

Sets the current colour and line drawing attributes.

• Comments

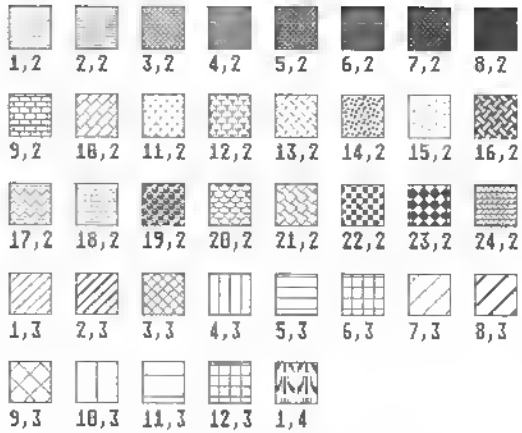
This sets the colour of the text subsequently output, as well as the the fill colour, the colour of lines drawn and the fill index and style. All parameters except *text_colour* are optional. In TOS programs only the first two parameters are acted upon. The following tables show the result of different parameters without the control panel present:

Number	*Colour*	*Number*	*Colour*
0	White	8	Grey
1	Black	9	Dark grey
2	Red	10	Light blue
3	Green	11	Blue green
4	Blue	12	Light purple
5	Dark blue	13	Dark purple
6	Brown	14	Dark yellow
7	Dark green	15	Light yellow

TT Low resolution	colours 0-255
TT Medium &ST Low resolution:	colours 0-15
ST Medium resolution:	colours 0-3
ST & TT High resolution:	colours 0-1

The actual colours displayed may differ from those above, depending on the current palette setting. To ensure the colours appear as above use the PALETTE statement.

If the *style* parameter is 0 then all fill operations will be in the text colour, or if it is 1 then they will be in the background colour. Values of *style* from 2 to 4 inclusive act together with *index* to produce the different fill patterns shown on the next page:



Index and Style Combinations

A *style* of 4 gives the same pattern regardless of *index*.

• Example

```
COLOR 1,1,1,1,4 ' Atari pattern
PCIRCLE 200,100,80
```

COMMAND$ function

• Syntax

COMMAND$

• Effect

This function returns the command line from the basepage of the program.

• Comments

This function enables a program to access the command line entered in the window produced by a .TTP or a GEM application installed as *TOS takes parameters* or with a particular file type. For example if you install MINE.PRG to accept .TXT files and double click on a .TXT file, the file's name is passed to MINE.PRG via COMMAND$.

Any leading spaces are removed from the command line and it is upper-cased.

• See

ENVIRON$.

• Example

```
OPEN COMMAND$ AS #1      ' a filename passed on the command
                         ' line is used to open a file
```


COMMON SHARED statement

• Syntax

```
COMMON SHARED variable [ (subscripts…)][,variable [
     (subscripts…)]]…
```

• Effect

This statement indicates that global variables may be accessed throughout any sub-programs.

• Comments

This statement is provided mainly for QuickBASIC compatibility.

It has the same effect as the DIM SHARED statement except that the subscripts of arrays are ignored. Arrays used in this statement should be DIMmed before the COMMON SHARED statement.

• Example

```
DIM glob(20)
COMMAND SHARED debug_flag,glob(1)
```

is equivalent to

```
DIM SHARED debug_flag,glob(20)

' both debug_flag and glob() can now be accessed anywhere
' in the 'program.
```

CONST statement

• Syntax

CONST *name=integer_constant* [,*name=integer_constant*]…

• Effect

CONST defines symbolic constant values for use in place of integer variables.

• Comments

Constants must be declared before they are used and their names must be valid integer variable names. *integer_constant* must be a simple integer number or character constant optionally preceded by a minus sign.

Constants can be used to make code that accesses data structures in memory much easier to read and also to give a loose equivalent to user enumerated types in Pascal.

Constants may be used within sub-programs and user-defined functions without declaring them as SHARED. Note that this is Note that this is *not* the same as the latest MicroSoft BASIC s where constants are local to sub-programs.

• See

DEFINT, *User Manual : Concepts* chapter.

• Example

```
DEFINT a-z
CONST white=0,black=1,red=2,green=3
COLOR red,green,black
CONST firstletter="A"%,lastletter="Z"%
IF (c%>=firstletter) AND (c%<=lastletter) THEN
    PRINT "It's a lower case letter"
```


COS function

• Syntax

COS(*numeric_expression*)

• Effect

This function returns the cosine of the *numeric_expression* , which must be in radians.

• Comments

COS is normally performed in single precision. If the *numeric_expression* is double precision, COS is performed in double precision.

• See

SIN, TAN, ATN.

• Example

```
PRINT COS(0)
```

Result:

1

CSNG function

• Syntax

CSNG(*numeric_expression*)

• Effect

This function converts *numeric_expression* to a single precision number.

• Comments

CSNG has the same effect as assigning *numeric_expression* to a single precision variable and then using that variable.

• See

MKS$, CDBL, CINT, CLNG.

• Example

```
PRINT SIN(1#)
PRINT CSNG(SIN(1#))
```

Result:

```
.8414709848078965
.841471
```


CSRLIN function

• Syntax

CSRLIN

• Effect

This function returns the current line position of the cursor.

• Comments

To return the current column position, use POS. The value returned is an integer, with the top of the screen (or window) returning the value of 1, corresponding to the LOCATE statement.

• See

POS, PRINT, LOCATE.

• Example

```
L%=CSRLIN
C%=POS(0)
PRINT "The cursor was on line";L%;"and in column";C%
```

Result (if the cursor is on line 2, column 3):

```
The cursor was on line 2 and in column 3
```

CURDIR$ function

• Syntax

CURDIR$ [(*string_expression*)]

• Effect

This function returns the current directory for a given drive or the current drive and directory if no *string_expression* is specified.

• Comments

The string returned always includes the drive name which ever form is used and is never terminated by a backslash (\).

Only the first character of the string_expression is considered and this is not case sensitive; thus CURDIR$("a") will return the same value as CURDIR$("A").

If the string passed is null then the current directory and drive are returned.

• See

CHDIR.

• Example

```
' assume the current drive is C and HBASIC is the current
' directory on that drive and that the current directory
on
' drive B is the root directory
PRINT CURDIR$,CURDIR$("B:"),CURDIR$("c")
```

Result:

```
C:\HBASIC      B:              C:\HBASIC
```


CVD,CVI,CVL,CVSfunctions

• Syntax

CVD(*8-byte string of a double precision float*)

CVI(*2-byte string of an integer*)

CVL(*4-byte string of a long integer*)

CVS(*4-byte string of a single precision float*)

• Effect

These functions return the internal numeric values of strings of bytes.

• Comments

These functions are the counterparts to MKD$, MKI$, MKL$ and MKS$. They do not change the value of the actual data, they only induce BASIC to interpret them differently.

The most common use for these functions is for processing random access files in which numeric values have been stores as strings by the MKD$, MKI$, MKL$ or MKSS functions.

• Example

```
D#=9/11
I%=10
L&=42
S!=5/7
PRINT D#,I%,L&,S!
OPEN "TEST.DAT" FOR OUTPUT AS #1
PRINT #1,MKD$(D#);MKI%(I%);MKL(L&);MKS(S!)
CLOSE #1
'The converted values of the different variables are
'binary. Printing these values to screen would result in
'strange looking control characters being displayed.
OPEN "TEST.DAT" FOR INPUT AS #1
D1$=INPUT$(8,#1)
I1$=INPUT$(2,#1)
L1$=INPUT$(4,#1)
S1$=INPUT$(4,#1)
CLOSE #1
PRINT CVD(D1$),CVI(I1$),CVL(L1$),CVS(S1$)
```

Result:

```
 .B181818127632141  10  42  7142857
 .8181818127632141  1D  42  7142857
```

DATA statement

• Syntax

DATA *constant* [,*next_constant*]...

• Effect

This statement defines the data to be used by the READ statement.

• Comments

DATA is not executed. It may contain as many constants as will fit on a line. READ will read DATA in the order of their appearance in the program. Multiple DATA statements will be processed as one continuous string of constants.

Constants may be of any variable type. If necessary the data will be converted into the correct type for the variable being READ.

It is not necessary for quotation marks to be present around string constants in DATA unless the string contains colons, commas, leading and trailing spaces or if it might be misconstrued as a inappropriate numeric value.

HiSoft BASIC stores data items internally as the appropriate type, thus 1.12345 will be stored as a single precision number requiring only 4 bytes of storage. Since you will normally read this into a single precision variable there is no need to convert it from ASCII to binary at run-time unlike with many BASICs. Should you read a number into a string variable it will be converted back into a string.

This does have the disadvantage that the string representation may not be the same as the original. For example, 11E1, will come out as 110. You can avoid this problem by enclosing such strings in quotes.

A null item in the list of constants is allowed. When read, a numeric variable it is assigned the value 0. If read as a string variable, the value will have the null value.

READ can process DATA statements again if RESTORE is used. Otherwise it is not possible to re-read DATA.

• See

READ, RESTORE, OPEN, INPUT$.

• Example

```
DATA 2.2,1.6,"Hello"
READ a,b%,c$
PRINT a;b%;c$
```

Result:

```
 2.2  2 Hello
```

The data item 1.6 is rounded before being assigned to the integer b%, hence the result of 2.

DATE$statement/function

• Syntax

DATE$

• Effect

This function returns the current date. It used as a statement, it can set the current date.

• Comments

The returned value is a ten character string. The format is *mm-dd-yyyy*. When setting the current date the following formats may be used:

mm-dd-yy

mm-dd-yyyy

mm/dd/yy

mm/dd/yyyy

Note that unlike previous versions of HiSoft BASIC the year may be any date from 1970 to 2069.

• See

TIME$, tgetdate% & tsetdate% GEMDOS functions.

• Example

```
d$=DATE$
IF RIGHT$(d$,4)>="1991" THEN
    PRINT "Today's date is: ";d$
ELSE
    PRINT "The system clock has not been set today"
    INPUT "Please enter today's date (mm-dd-yy): ";d$
    DATE$=d$
END IF
```


DECLARE statement

• Syntax

DECLARE [SUB|FUNCTION]*routine_name* [(*parameter_list*)]

or

DECLARE [SUB|FUNCTION]*routine_name* [CDECL][ALIAS
"externalname"][(*parameter_list*)]

• Effect

Declares a BASIC sub-program or function before it is defined or declares an externally linked sub-program or function..

• Comments

When used without CDECL this declares a BASIC sub-program or function so that you can use it before it is defined. The routine_name and parameter list should appear in exactly the same form as in the definition in the SUB or FUNCTION statement. The use of DECLARE for sub-programs is optional in HiSoft BASIC but is required in the latest MicroSoft BASICs. All dialects require FUNCTIONs to be defined before they are used to avoid confusion with ordinary variables or arrays.

If you DECLARE a function or sub-program but do not define it the compiler will give an error 48 unless you have used the Allow undefined sub-programs option (]).

When CDECL is included this statement declares an external routine, written in C or assembler that will be linked with the program. The optional parameter list is of exactly the same format as for a BASIC sub-program or function. The use of this command causes HiSoft BASIC to generate a Lattice format linkable file rather than an executable one. See *Appendix F* for more details.

The name of the external routine is taken to be the externalname specified in the ALIAS clause if this is present. This is the exact name that will be used - the casing of letters will not be modified. If the ALIAS clause is missing the BASIC name without any type specifier is made lower case and an under-score (_)character is inserted at the front. This is appropriate for linking with Lattice C routines.

• See

FUNCTION, SUB, *User Manual : Concepts* chapter, *Appendix F: Linking.*

• Example

```
DECLARE FUNCTION double(BYVAL i)

PRINT double(23)

FUNCTION double(BYVAL i)
double=i*2
END FUNCTION

DECLARE SUB External CDECL (BYVAL i%)

External 23
' This calls _external with a parameter of 23 on the stack

DECLARE FUNCTION Comp CDECL(BYVAL a!,BYVAL b!)
DECLARE SUB assem CDECL ALIAS "assembler" (BYVAL
para1&,para2)
DECLARE SUB no_paras CDECL ALIAS "ASSEM"
DECLARE FUNCTION cfunc& CDECL
```


DECR statement

• Syntax

DECR *numeric_variable*

• Effect

Subtracts one from the specified variable

• Comments

numeric_variable may be a simple numeric variable or a numeric array element of any type. If you wish to decrement a simple variable X it probably makes more sense stylistically to use X=X-1 rather than DECR X, but if you have a complicated array expression as below DECR is the appropriate construct.

• See

INCR.

• Example

```
DECR A(B(I,j+5)) 'equivalent to A(B(I,j+5))=A(B(I,j+5))-1
```

DEF FN statement

• Syntax

```
DEF FNfunction_name[(parameter_list)]=expression
                or
DEF FNfunction_name[(parameter_list)]
[LOCAL variable_list]
[STATIC variable_list]
[SHARED variable_list]
.
.
statements
.
.
[EXIT DEF]
[FNfunction_name=expression]
.
.
END DEF
```

• Effect

Define old style single- or multi-line functions with parameters.

• Comments

In general we recommend that you use FUNCTIONs rather than this old style of DEF FN as FUNCTIONs can easily be turned into sub-programs and vice versa.

The *function_name* must be a unique identifier in your program. The optional *parameter_list* can contain any number of variable names separated by commas, each of which may be preceded by VARPTR to denote variable rather than value parameters (see the *User Manual : Concepts* chapter for more details of parameter types).

The *function_name* must be a variable name and the type returned is determined by the same rules as for variables. Thus FNfred% returns an integer. FNjohn will normally return a single precision floating point value unless you have used a DEFtype statement affecting the letter J. Note that DEF FN function names must be preceded by FN.

Inside function definitions, variables are assumed to be global unless you use a STATIC or LOCAL statement to override this.

Function definitions may be recursive and functions may be called before they are declared. However function definitions can not be nested inside other function or sub-program definitions or within structured control statements.

FN*function_name=expression* is used to return values from multi-line functions. You can have more than one such statement within a function definition.

EXIT DEF causes the current function to be exited immediately.

If you call multi-line functions from within expressions, be careful that you do not have problems with side effects. For example

```
DEF FNx
  j=j+1
  FNx=j
END DEF
j=4
PRINT FNx+j
```

will probably not produce the same result as

```
j=4
PRINT j+FNx
```

because the variable j is modified when the function is called.

It is also dangerous to use input/output statements within multi-line functions if you then call them from within another input/output statement. For example,

```
PRINT 54,FNsilly,j
DEF FNsilly
PRINT " Function silly is being called."
FNsilly=1.4
END DEF
```

is not sensible.

The best idea is either never to call functions in input/output *or* never to input/output within functions.

• See

FUNCTION, *User Manual : Concepts* chapter.

• Example

```
DEF FNahex$(a&)="&H"+hex$(a&)
DEF FNlonghex$(a&)
STATIC a$
a$=hex$(a&)
IF LEN(a$)<8 THEN
    a$=STRING$(8-LEN(a$),"0")+a$
END IF
FNLonghex$=a$
END DEF
PRINT FNahex$(42),FNlonghex$(42)
```

DEF SEG statement

• Syntax

DEF SEG=*numeric_expression*

• Effect

This statement defines the mode of operation of PEEK and POKE.

• Comments

In general we recommend the use of the PEEKB, PEEKW, PEEKL, SPEEKB, SPEEKW or SPEEKL functions and their POKE counterparts rather than the use of DEF SEG, PEEK and POKE which are provided for ST BASIC compatibility. The new style statements are faster and easier to understand.

If *numeric_expression* in a DEF SEG statement is greater than 0 then 1 byte is PEEKed or POKEd and the value of the *numeric_expression* is used as an offset of the address passed to PEEK or POKE.

If *numeric_expression* = 0 and the address given to PEEK or POKE is of type single or integer then 2 bytes are PEEKed or POKEd.

If *numeric_expression* = 0 and the address passed is of type long integer or double, then 4 bytes are PEEKed or POKEd.

The *numeric_expression* is a long integer.

• See

POKE, PEEKB, PEEKW, PEEKL, POKEB, POKEW, POKEL.

• Example

```
REM $option G
DEF SEG=&HFFFF8200  'start of screen hardware
old=PEEK(3)         'protected byte-peek
POKE 3,old-1        'hack screen position
' the screen will have moved about a little at this point
INPUT a$            'wait for a key
POKE 3,old          'then restore screen
```


DEFDBL, DEFINT,DEFLNG, DEFSNG, DEFSTR statements

• Syntax

DEFDBL *letter_range* [,*letter_range*]...
DEFINT *letter_range* [,*letter_range*]...
DEFLNG *letter_range* [,*letter_range*]...
DEFSNG *letter_range* [,*letter_range*]...
DEFSTR *letter_range* [,*letter_range*]...

• Effect

These statements declare variables and functions to be double precision, integer, long integer, single precision, or string.

• Comments

The format of the *letter_range* is *1st_letter* [-*2nd_letter*]. Allowable letters are upper- or lowercase. Any variable or function name beginning with a letter specified in a DEF*type* statement defines the value of the variable: DBL for double precision, INT for integer, LNG for long integer, SNG for single precision, or STR for a string.

The type declaration characters #,%,&,!,$ override any DEF*type* statements.

Note: The variables I#, I%, I&, I!, and I$ are all different variables with potentially different values.

• See

User Manual : Concepts chapter.

• Example

```
DEFINT a-z  ' a good idea to have at the front of all
            ' programs so you only use floating point
            ' when needed and avoids many %s in names.
DEFINT i-n
DEFSNG a-h,o-z  ' for old-fashioned FORTRAN programmers
                ' but confusing for everyone else.
```

DIM statement

• Syntax

```
DIM [SHARED]variable [ (subscripts…)]
     [,variable [ (subscripts…)]]…
```

• Effect

This statement defines the maximum values for array-variable subscripts and allocates the necessary storage.

• Comments

The maximum subscript value for an unDIMmed array is 10. The maximum number of dimensions in an array is 31 (which would take up a minimum of 4 GigaBytes of memory if each index had more than one possible element). Subscript values can be integer or long integer expressions.

It is good programming practice to dimension all arrays even if you require 10 elements as this will enable you to switch off the array checks option.(A-) To ensure that you are not auto-dimensioning an array by mistake, use the Array Checks Warnings option (a+[)

The minimum value for each subscript may be set using the OPTION BASE statement.

If you use REM $DYNAMIC in your program, all subsequent arrays that you dimension will be dynamic and can be modified with ERASE, REDIM, and REDIM PRESERVE. By default, or after using REM $STATIC arrays will be static if the first dimension statement uses constants rather than more general expressions. Static arrays may not be ERASEd or REDIMensioned but they are accessed considerably faster.

When initially defined, the elements of a numeric array have the value 0. If a string array is defined, the elements have null values.

The DIM SHARED form is used to declare arrays and ordinary variables that can be accessed from within sub-programs without the need for a SHARED statement in each sub-program.

• See

ERASE, REDIM, STATIC, LOCAL, *User Manual : Concepts* chapter, *Appendix B: Compiler Options.*

• Example

```
DIM R(15)
FOR I%=1 TO 15
    R(I%)=I%
    PRINT R(I%);
NEXT I%
```

Result:

```
 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15
```

```
DIM SHARED debug_flag   'debug_flag can now be
                'accessed anywhere in the program.
CONST maxsize=100
varsize=100
DIM a(100),b(maxsize),c(varsize),d(maxsize*2)
' a & b are static arrays c & d are dynamic one so
ERASE c
REDIM d(varsize)
'are fine but
ERASE a
REDIM b(varsize)
'are illegal
```

DO...LOOP statement

• Syntax

```
DO [{WHILE|UNTIL} boolean_expression]
.
.
[EXIT {DO|LOOP}]
.
.
{WEND|LOOP}[{WHILE|UNTIL} boolean_expression]
```

• Effect

Repeats the statements within the DO...LOOP while the conditions are true (WHILE) or false (UNTIL).

• Comments

The *boolean_expressions* must be numeric expressions. If they evaluate to 0 this is taken as false; non-zero as true.

If an EXIT DO or EXIT LOOP statement is contained within the loop then control passes to the statement following the end of the loop. EXIT DO is the preferred form as this is used by MicroSoft BASIC.

If DO...LOOPs are nested the inner most loop is exited. If you wish to exit an outer loop use the REPEAT loop construct, but note that unlike DO...LOOPs these are are not portable to MicroSoft BASIC.

here may a condition at both ends of the loop if desired or none at all; this is thus considerably more flexible than the WHILE..WEND loop.

• See

WHILE, REPEAT.

Examples

```
i=0
DO
    i=i+1
    PRINT i;
LOOP UNTIL i>=10
```

Result:

```
 1  2  3  4  5  6  7  8  9  10
```

```
i=0
DO
    i:=i+1
    IF i>10 THEN EXIT DO
    PRINT i
LOOP
```

Result:

```
 1  2  3  4  5  6  7  8  9  10
```

ELLIPSE statement

• Syntax

```
ELLIPSE x_centre,y_centre,x_radius,y_radius
     [,start_angle,end_angle]
```

• Effect

Draws an ellipse or elliptical arc in the current window.

• Comments

If the optional angle parameters are omitted, the command draws a hollow ellipse in the current line colour (the third parameter in the COLOR statement). The angle parameters are expressed in degrees times 10, and are measured anti-clockwise starting on the right side. Solid ellipses and arcs can be drawn using the PELLIPSE command. All the parameters are integers.

The x_centre and y_centre co-ordinates are based on the top left of the current window being (0,0) unlike the GEMVDI v_ellipse command where (0,0) is the top left of the *screen*.

• See

PELLIPSE, CIRCLE, PCIRCLE, v_ellipse GEMVDI command.

• Example

```
ELLIPSE 200,100,75,50
ELLIPSE 100,100,50,100,225,1750
```


END statement

• Syntax

```
END
END DEF
END FUNCTION
END IF
END REPEAT name
END SELECT
END SUB
```

• Effect

Ends a BASIC program, function definition, IF...THEN...ELSE block, SELECT statement, REPEAT loop or sub-program.

• Comments

The END DEF statement indicates the end of a DEF FN.

END IF finishes an IF...THEN...ELSE block.

END FUNCTION indicates the end of a FUNCTION definition.

END REPEAT name ends a REPEAT loop.

END SELECT ends a SELECT CASE statement.

END SUB ends a BASIC sub-program; it is the counterpart of SUB. See the relevant statement for more details.

END alone terminates the entire BASIC program. The END statement may be put anywhere in the source.

• See

EXIT.

• Example

```
FUNCTION factorial&(BYVAL N%)
    IF N% <= 1 THEN
        factorial&=1
    ELSE
        factorial& = factorial&(N%-1)*N%
    END IF
END FUNCTION
```

ENVIRON statement

• Syntax

ENVIRON *string_expression*

• Effect

Modifies , creates or deletes an environment variable..

• Comments

The string expression must be of the form:

envname=envvalue

or

envname envvalue

where the separator is a space. Either form will set the environment variable envname to have the value envvalue. If the envvalue is null or consists just of a single semi-colon then the environment variable will be deleted. This will effect the current program and any programs that are run within it; it won't change the environment of the parent process.

The environment string is stored in TOS memory, so if you are adding many strings to the environment ensure that you have left enough room for the operating system. Note that MicroSoft BASIC under MS-DOS does not re-allocate space for the environment in this way.

• See

ENVIRON$ function, COMMAND$.

• Example

```
ENVIRON "FRED=Hello"
    ' sets the environment variable FRED to be HELLO

ENVIRON "CLINKWITH="
'and
ENVIRON "CLINKWITH=;"
'both remove any CLINKWITH environment variable.
```


ENVIRON$ function

• Syntax

ENVIRON$(*string_expression*)

or

ENVIRON$(*integer_expression*)

• Effect

Reads the value of an environment variable..

• Comments

To find the current value of a given environment variable pass its name as a string .The string should *not* be terminated with an equals sign. A null string will be returned if the value can not be found. Note that this function is case sensitive so you should normally pass an upper case string and that just the value of the variable is returned without its name.

To find the names and values of the existing environment variables pass an integer i to ENVIRON$ and it will return the ith name in the environment and its value. If there is no such variable the null string is returned. See the example below.

• See

ENVIRON statement, COMMAND$.

• Example

```
PRINT ENVIRON$("PATH")
' prints the current value of the PATH environment
variable

' display all the current environment variables
i=1
DO
  cur$=ENVIRON$(i)
  IF cur$="" THEN EXIT DO
  PRINT cur$
  i=i+1
LOOP
```

EOF function

• Syntax

EOF(*channel_number*)

• Effect

This function tests for the end-of-file condition of *channel_number*.

• Comments

-1 is returned if true; 0 if false. A common use for EOF is to test for the end-of-file when writing data to a sequential file. When writing to a random-access file, EOF returns true if the last GET was not able to read an entire record, due to an attempt to read beyond the end-of-file. The result returned is an integer.

• See

OPEN, LOF, LOC.

• Example

```
OPEN "TEST.DAT" FOR INPUT AS #1
Ctr=0
WHILE NOT EOF(1)
    junk$=INPUT$(1,#1)
    Ctr=Ctr+1
WEND
CLOSE #1
PRINT Ctr       'The length of the file in
                'bytes can use LOF instead.
```


ERASE statement

• Syntax

ERASE *array_name* [, *array_name*]...

• Effect

This statement de-allocates dynamic arrays previously defined with DIM.

• Comments

An array once ERASEd can only be accessed again after is has been DIMmed. REDIM alone will ERASE and DIM an array together, whereas REDIM PRESERVE allows an array to be extended or truncated without losing its remaining data. This command can move existing arrays in memory, so extreme care should be taken if used within functions or sub-programs that are called with arrays or array elements as variable parameters.

Note that only dynamic arrays may be ERASEd.

See the *User Manual : Concepts* chapter for more details.

• See

DIM, REDIM, *User Manual : Concepts* chapter.

• Example

```
REM $dynamic
DIM Arr(15000)

' some processing with Arr()

ERASE Arr       ' free the space used by Arr
```

ERL, ERR functions

• Syntax

ERL

ERR

• Effect

These functions return error status of the current program.

• Comments

When running an error handling routine, ERR will return the error code and ERL returns the line number in which the error occurred. Note that if the error occurred on a line without a line number, the most recent line number found in the program will be returned in ERL.

If no line number at all has been encountered ERL will return the physical line number where the error occurred. Note that this is the line number after any include files have been inserted by the compiler. This behaviour without line numbers is a HiSoft BASIC 2 extension.

• See

ON ERROR, ERROR.

• Examples

```
IF ERR=53 THEN
    PRINT "File not found error on or after line ";ERL
END IF
.

99 PRINT "FINISHEO"
   RETURN
    I=0
    PRINT 1/I
'After executing 1/I the value of ERL will be 99 even
'though this line number has nothing to do with the code
'executed.
```


ERROR statement

• Syntax

ERROR *integer_expression*

• Effect

This statement simulates the occurrence of a BASIC run time error.

• Comments

ERROR is the counterpart to ERR in that *integer_expression* is the code returned by ERR. The user can also create his own error codes by using error numbers not already used by BASIC.

• See

ERL, ERR, ON ERROR.

• Example

```
IF Tst <= 0 THEN ERROR 99    'An error code not reserved
                             'by BASIC
IF ERR = 99 THEN
    PRINT "Something has gone terribly wrong in SUB TEST"
END IF
```

EXIT statement

• Syntax

EXIT {DEF|DO|FUNCTION|IF|FOR|LOOP|SELECT|SUB|*identifier*}

• Effect

Exits a function definition, BASIC sub-program or a structured statement.

• Comments

EXIT DEF exits from a function definition whereas EXIT SUB exits from a sub-program. EXIT DO, EXIT IF, EXIT FOR, EXIT FUNCTION, EXIT LOOP and EXIT SELECT cause the corresponding structured statement to be exited immediately and execution continues with the statement after the corresponding END.

EXIT identifier causes the named REPEAT loop to finish prematurely.

These statements are used to leave routines (e.g. as part of an IF...THEN...END IF block). They do not define the end of the routines definitions; END DEF, END FUNCTION, END SUB and END REPEAT identifier are required to do this.

• See

DO, IF, FOR, FUNCTION, LOOP, SELECT, SUB.

• Example

```
SUB Fred
.
.
IF Var&=12654 THEN EXIT SUB
.
.
END SUB
FOR i=1 TO max
    IF a(i)=0 THEN EXIT FOR
NEXT i
IF i>max THEN
    PRINT "no zero elements"
ELSE
    PRINT "first zero element is";i
END IF
```


EXP function

• Syntax

EXP(*numeric_expression*)

• Effect

Calculates the exponential function of the *numeric_expression*.

• Comments

This function returns *e* to the power of the *numeric_expression*. *e* is the base of natural logarithms. If the *numeric_expression* is double precision then the result is calculated to double precision otherwise single precision is used.

• See

LOG.

• Example

```
PRINT EXP(1#)
```

Result:

```
2.718281828459046
```

FEXISTS function

• Syntax

FEXISTS(*filename*)

• Effect

Determines whether or not a particular file exists.

• Comments

filename should be a legal GEMDOS filename, together with a drive specifier and sub-directory if required. The function returns -1 if the file is found, or 0 if it is not.

• See

OPEN.

• Example

```
f$="TEST.DAT"
IF NOT FEXISTS(f$) THEN
    f$="B:\"+f$
    IF NOT FEXISTS(f$) THEN
        do_error "Cannot find data"
    END IF
END IF
OPEN f$ FOR INPUT AS #1
```


FIELD statement

• Syntax

FIELD [#]*channel_number*, *field_width* AS *string_variable*…

• Effect

This statement allocates space for variables in a random access buffer.

• Comments

The *channel_number* is the number which was used to OPEN the file. *field_width* is the amount of space in the *string_variable* to be allocated, in characters.

The total number of bytes allocated must not exceed the record length specified when opening the file; default record length is 128 bytes.

When a file is CLOSEd, all FIELD definitions are lost. All fielded strings that BASIC associates with the file receive null values.

A FIELD statement does not cause data to be put into the buffer. It associates a specified amount of space within the random-access buffer with a variable.

Note: Do not use a fielded variable in an INPUT statement if it is to remain fielded. An INPUT or other assignment will cause the variable's pointer to refer to string space, not the random-access buffer. You should use LSET and RSET to assign to field variables.

• See

OPEN, GET, PUT, LSET, RSET, *User Manual : Concepts* chapter.

• Example

```
'The first definition allocates the 12 byte buffer as the
'country code, area code and phone number; the second
'allocates the same buffer entirely to the single
'variable of Wholenum$.
OPEN "JOHN.DAT" FOR INPUT AS #1 LEN=12
FIELD #1, 2 AS Ccode$, 3 AS Acode$, 7 AS Number$
FIELD #1, 12 AS Wholenum$
```

FILES statement

• Syntax

FILES [*file_spec*]

• Effect

This statement lists the names of files in the specified directory on a disk.

• Comments

The *file_spec* must be a string conforming to GEMDOS conventions and may contain a drive letter, pathname, and file name including wildcards. If *file_spec* is omitted, the current directory of the current drive is listed.

The format if the directory is the same as that produced by Microsoft BASIC, except the free space remaining on the disk is not printed, because of the time taken by such a function under TOS versions prior to 1.04.

• Example

```
FILES "A:\DEVPAC\*.S"    'This produces a list of all
                         'the files in the DEVPAC
                         'directory of the disk in
                         'drive A: which have the
                         'extension S.
```


FILL statement

• Syntax

FILL *x_start*,*y_start*

• Effect

This statement fills enclosed shapes already drawn on the screen.

• Comments

The pixel in the current output window specified by *x_start* and *y_start* is plotted and the pattern 'spreads out' to fill the whole of the shape. The current fill colour, style and index, as selected by the COLOR statement are used.

The x_start and y_start parameters are specified relative to the current window, unlike the corresponding GEMVDI command v_contourfill.

• See

v_contourfill.

• Example

```
COLOR 1,1,1,0,0
BAR 70,40,160,120              ' hollow box
ELLIPSE 150,100,70,50          ' and ellipse
COLOR 1,1,1,1,4
FILL 71,50
```

FIX function

• Syntax

FIX(*numeric_expression*)

• Effect

This function produces the truncated integer part of the *numeric_expression*.

• Comments

The difference between FIX and INT is that if the *numeric_expression* is negative, FIX will return the first negative integer greater than itself, whereas INT returns the first negative integer less than the *numeric_expression*. The type of the result will be the same as the type of *numeric_expression*.

• See

INT, CINT, CLNG, CDBL, CSNG.

• Example

```
PRINT FIX(1.5)
PRINT FIX(-1.5)
```

Result:

```
 1
-1
```


FOR...NEXT statement

• Syntax

```
FOR counter = start TO end [STEP increment]
.
.
NEXT [counter ][,counter]…
```

• Effect

This statement executes a series of instructions in a loop a specified number of times.

• Comments

counter	is a variable used as the loop counter
start	is the value of *counter* at the beginning of the loop
end	is the value of *counter* upon which the loop ceases to execute
increment	is the value by which *counter* is incremented each time the loop is executed

All four values may be either integers, long integers, single or double precision floats.

The program lines between FOR and NEXT are executed repeatedly. *counter* is adjusted by *increment* after execution of each iteration of the loop. *counter* is then compared with *end*. If *counter* is greater than *end*, execution of the program continues on the line after NEXT.

Note that *counter* is updated before the comparison is made.

Unless STEP *increment* is specified, the increment value is one. If *increment* is negative, *end* must be less than *start* otherwise the loop will not be executed.

If *start* is less than *end* and *increment* is positive then the loop isn't executed.

FOR…NEXT loops may be nested, provided that each loop has a unique *counter* variable. The NEXT statement for the inside loop must appear before the NEXT statement for the outside loop.

A NEXT statement of the format NEXT x,y,z is the same as

```
        NEXT x
    NEXT y
NEXT z
```

A NEXT statement without specifying *counter* will match the most recent FOR statement.

FOR...NEXT loops may finish prematurely via the use of EXIT or GOTO statements.

Note: The sum of *end* and *increment* (even of *increment* isn't explicitly specified, and is therefore one) must never exceed the range of *counter*'s variable type otherwise overflow results.

Optimisation: A FOR...NEXT loop executes fastest when *counter* is a integer and *start*, *end* and *increment* are constants. If any of the last three values must be variables, they should be made integers for maximum speed.

• See

WHILE, DO...LOOP.

• Example

```
DEFINT I
FOR I_ONE = 1 TO 5
    FOR I_TWO = 3 TO 11 STEP 2
        FOR I_THREE = 0 TO -15 STEP -1
'
.
NEXT I_THREE,I_TWO,I_ONE
```


FORMATI$, FORMATL$, FORMATS$ and FORMATD$ functions

• Syntax

```
FORMATI$(integer_expression,string_expression)
FORMATL$(long_expression,string_expression)
FORMATS$(single_expression,string_expression)
FORMATD$(double_expression,string_expression)
```

• Effect

Theses functions format numeric expressions in a similar manner to the PRINT USING and PRINT statements but they produce their result as a string.

• Comments

These functions can be used to convert numbers to strings for manipulation yourself rather than for direct output. If the *string_expression* is null then the string produced consists of the characters that would be printed in a normal PRINT statement; otherwise *string_expression* is used as a PRINT USING format string. See the PRINT USING statement for full details of this formatting.

These functions are particularly useful when displaying numbers in dialog boxes or when printing directly with GEMVDI.

• See

PRINT USING, PRINT, STR$.

• Example

```
WRITE FORMATI$(12,""),FORMATI$(12,"###")
WRITE FORMATS$(1E10,""),FORMATS$(1E10,"##.##^^^^")
WRITE FORMATD$(1E10,""),FORMATD$(1E10,"##.##^^^^")
```

Result:

```
" 12 "," 12"
" 1E+10 "," 1.00E+10"
" 10000000000 "," 1.000+10"
```

FRE function

• Syntax

FRE(*numeric_expression*)

FRE(*string_expression*)

• Effect

This function returns the size of free heap space or GEMDOS free memory.

• Comments

FRE returns the following values:

For a *numeric_expression* which is not equal to -1, the size of the free space on the BASIC heap is returned. For compatibility with other versions of HiSoft BASIC use zero or a positive value for this. For -1, the size of GEMDOS free memory is returned.

For a *string_expression*, the size, in bytes, of contiguous free heap space after a garbage collect is returned.

The *heap* is the area of memory used by a BASIC program for storing string variables and arrays. It is used up as your program executes string expressions but the garbage thus created will be 'cleaned up' automatically by the garbage collector. Thus the value returned by FRE(0) becomes smaller and smaller until a garbage collect occurs when it will return to a much larger value.

• Example

```
PRINT FRE(0)
PRINT FRE("")       'This is a null string
PRINT FRE(-1)
```

Result:

```
 127534
 154293
 4096
```


FREEFILE function

• Syntax

FREEFILE

• Effect

This function returns the first free file number as an integer.

• Comments

FREEFILE can be used in sub-routines to obtain a free file channel number for file input/output so that you can proceed without worrying about which file numbers are already used by the program.

• See

OPEN, CLOSE.

• Example

```
'This routine displays a text file on the screen without
'interfering with any existing files in use
SUB ShowFile(filename$)
STATIC myfile,temp$
myfile=FREEFILE
OPEN filename$ FOR INPUT AS #myfile
WHILE NOT EOF(myfile)
    LINE INPUT #myfile,temp$
    PRINT temp$
WEND
CLOSE myfile
END SUB
```

GET file I/O statement

• Syntax

GET [#]*channel_number*[,*record_number*]

• Effect

This statement reads a record from a random-access disk file into a random access file buffer.

• Comments

The *channel_number* is the number under which the file was opened. If *record_number* is omitted, the next record after the last GET is read.

EOF is useful to use in conjunction with GET to check if GET was beyond the actual end of the file.

• See

OPEN, FIELD, PUT, INPUT#, *User Manual : Concepts* chapter.

• Example

```
'This routine prints the names and ages of the first 10
'people listed in AGES.DAT
DEFINT I
OPEN "AGES.DAT" FOR RANDOM AS #1
FIELD #1, 10 AS Fname$, 10 AS Lname$, 2 AS Age$
FOR I = 1 TO 10
    GET #1,I        'Read the first 10 entries in AGES
    PRINT Fname$;" ";Lname$;" is ";Age$;" years old."
NEXT I
CLOSE #1
```


GET graphics statement

• Syntax

GET(*x1,y1*)-(*x2,y2*),*array_name*[(*index_expression…*)]

• Effect

This statement stores binary images from any part of the screen.

• Comments

GET transfers a rectangular image defined by (*x1,y1*)-(*x2,y2*)into the array specified by *array_name*. PUT is the counterpart statement; it transfers the image from the array to the screen.

(*x1,y1*)-(*x2,y2*) represent diagonally opposite corners of the rectangle on the screen.

Note that the co-ordinates are expressed relative to the top left of the screen, not the current window, unlike most other graphic commands.

The size (in bytes) of an array needed to store an image is

```
2*p*(y2-y1+1)*[(x2-x1)\16+1] + 6
```

where p is the number of planes of screen memory, i.e. 1 for high resolution, 2 for medium and 4 for low. For example to store an image of (10,20)-(100,200) in low resolution would require 2*4*181*6+6=8694 bytes, or an integer array of 4347 elements.

The GET command has its own idea of the *current* screen; to change the current screen (e.g. for animation) you should update the long word at SYSTAB+50.

If an integer array p%() is used in a GET statement then

p%(0)	contains the width of the image
p%(1)	contains the height of the image
p%(2)	contains the number of planes in the image.

Note that this form of array is compatible with HiSoft BASIC on the Amiga but is *not* the same as for HiSoft BASIC 1 on the ST.

Multi-dimensional arrays may be used in this statement, making it easy to switch between different images.

The following example shows how to get the entire screen in a resolution independent way that will work in any ST or TT mode or with any add-on screen for that matter.

• See

PUT, SYSTAB, vro_cpyfm VDI command.

• Example

```
p=PEEKW(SYSTAB)          'planes
x1%=PEEKW(SYSTAB+40)     'workstation co-ordinates
y1%=PEEKW(SYSTAB+42)
x2%=PEEKW(SYSTAB+44)
y2%=PEEKW(SYSTAB+46)
DIM whole%(CLNG(p)*(y2-y1+1)*[(x2-x1)\16+1] + 2) 'just
GET (x1,y1)-(x2,y2),whole%  'get the whole screen

'display it 10 pixels down and to the right
PUT (10,10),whole%,PSET

DIM pics%(2,2503)   'enough for 16 colours
....
GET (0,0)-(99,99),a(1,0)
...
GET (0,0)-(99,99),a(2,0)
FOR i=1 TO 2          'display both
    PUT (0,0),a(i,0),PSET
    INPUT a$
NEXT i
```


GETCOOKIE function

• Syntax

`GETCOOKIE(string_expression,long_integer_variable)`

• Effect

Reads the value of a 'cookie' from the Cookie Jar. The value returned by the function is -1 if the cookie is found or 0 if it is not.

• Comments

The Cookie Jar is a convention, introduced in STE TOS, whereby the system (and third party suppliers) can indicate the capabilities of an Atari TOS machine.

Each cookie has a 4 character name and a long integer value. Cookies beginning with _ are reserved for Atari's system cookies and, at the time of writing, are as follows:

_CPU — the bottom 2 digits of the main processor number (e.g. 0 for 68000, 30 for 68030)

_VDO — the major/minor part number of the video shifter. At present the least significant word is always zero and the high word is one of

0 ST
1 STE
2 TT

_SND — This is bit oriented as follows:

bit 0 1 if ST style GI/Yamaha chip available

bit 1 1 if TT/STE style DMA sound available

_MCH — This is rather more vague and gives the machine type. As with _VDO this consists of a a high word as follows:

0 520/1040 or Mega ST

1 STE

2 TT

The low word is normally zero except in the case of the MegaSTE where the low word is 16. Thus _MCH is &h10010 for the MegaSTe.

Normally you should use the more specific cookies given above, in case some one has added a 68030 processor to an STE, for example.

_SWI — The Mega STE and TTs have have internal configuration switches; this gives their value. However normally you should not access this directly; another cookie would be more appropriate.

_FRB — 'Fast RAM Buffer'.This is used on the TT to give the address of a 64K buffer in system (chip or ST) RAM that all ACSI devices performing DMA can use, when transfers to TT RAM are requested. It is not present if their is no fast RAM.

_FPU — This gives an indication of any Floating Point Unit installed in the machine. As with _VDO and _MCH only the high word is used at the time of writing. Bit 0 is used to indicate if an I/O mapped 68881 is present (like Atari's SFP004 or on the MegaSTe). The following values of Bits 1 to 3 indicate

1	68881 or 68882 (unsure which)
2	definitely 68881
3	definitely 68882
4	68040 internal floating point support

Note that the table above does not give the usage of the individual bits but the value given by those 3 bits together.

Thus on a machine with a 68882 and no I/O mapped processor this cookie will have the value &h2000 or &h6000.

The reason for the 'unsure' status is that the BIOS detects whether a co-processor is present, but does not attempt to determine which one.

At the time of writing most Mega STs with I/O mapped co-processors do *not* have a cookie jar.

Although the cookie jar was introduced with STE TOS it can be retro-fitted to earlier STs

• Example

```
IF GETCOOKIE("_CPU",cpu&) THEN
    PRINT "This machine has a ";68000+cpu&;" processor"
ELSE
    PRINT "This machine doesn't have a _CPU Cookie"
    PRINT "So its probably a 68000"
END IF


IF GETCOOKIE("_VDO",vdo&) THEN
    IF (vdo& AND &hFFFF0000)=&h20000 THEN
        'Now we can use the XBIOS TT video calls
    ....
    END IF
```


GOSUB...RETURN statements

• Syntax

```
GOSUB {line_number1|line_label1}
.
.
RETURN {line_number2|line_label2}
```

• Effect

These statements branch to, and return from, a subroutine, respectively.

• Comments

line_number1 or *line_label1* identifies the first line of the subroutine to which GOSUB branches. You can also RETURN from a subroutine to *line_number2* or *line_label2* and not necessarily to the line after the GOSUB call. This is not generally recommended as it can lead to very unreadable code.

A subroutine may contain more than one RETURN statement. A RETURN without *line_number2* or *line_label2* branches back to the line after the GOSUB that called the subroutine.

Note: We suggest that you use CALLs to SUB...END sub-programs rather than GOSUB...RETURN. SUB...END routines are much more flexible in that parameters can be passed to them, they can support local variables.

HiSoft BASIC does not support GOSUB to a sub-program.

• See

SUB, FUNCTION.

• Example

```
I% = 0
PRINT "Main Loop"
GOSUB Loop1
Back_In_Main:
PRINT "Back in Main Loop"
I% = 1
GOSUB Loop2
PRINT "Done.
END
.
.
Loop1:
PRINT "In 1st subroutine"
RETURN Loop2
```

```
Loop2:
PRINT "In 2nd subroutine"
    IF I% = 0 THEN
        RETURN Back_In_Main
    ELSE
        RETURN
    END IF
```

Result:

```
Main Loop
In 1st subroutine
In 2nd subroutine
Back in Main Loop
In 2nd subroutine
Done
```


GOTO statement

• Syntax

`GOTO {line_number|line_label}`

• Effect

This statement causes program execution to unconditionally jump to the line specified.

• Comments

GOTOs must *not* be used to enter or leave functions, subprograms or subroutines. GOTOs can be used within these structures if necessary.

Note: We suggest the use of structured control statements such as IF...THEN...ELSE and DO...LOOP for enhanced readability of the source and easier debugging. If you need to use a GOTO use a meaning label rather than a line number.

• See

IF, DO, EXIT.

• Example

```
GOTO Label
'The program never gets here
.
.
Label:
PRINT "The program resumes execution here"
```

GOTOXY statement

• Syntax

GOTOXY *x_character,y_character*

• Effect

Move the text cursor to a particular location on the screen.

• Comments

The top-leftmost position on the screen or output window is (0,0).

Note: In order to be compatible with the first version of ST BASIC *x_character* is doubled before the cursor is positioned when in high resolution.

It is recommended that the LOCATE statement is used instead, as it allows more accurate cursor positioning. Note that LOCATE has the parameters in the opposite order and that (1,1) is the top left.

• See

LOCATE, PRINT, POS, CSRLIN.

• Example

```
GOTOXY 0,21
INPUT "Enter name:",n$
```


HEX$ function

• Syntax

HEX$(*numeric_expression*)

• Effect

This function returns a string that represents the hexadecimal value of the *numeric_expression*.

• Comments

The *numeric_expression* is rounded before being evaluated by HEX$. If the parameter is an integer then the resulting string will be from 1 to 4 characters in length, and if it is a long integer then the result may be up to 8 characters in length.

• See

OCT$, BIN$.

• Example

```
'This routine prints the numbers 1 to 15 in hexadecimal
'notation
DEFINT I
FOR I=1 TO 15
    PRINT HEX$(I);
NEXT I
```

Result:

```
123456789ABCDEF
```

IF...THEN...ELSE statement

• Syntax

```
IF boolean_expression THEN
     statement_1
     [statement_2]
.
.
[ELSEIF boolean_expression THEN
     statement_3
     [statement_4]]
.
.
[ELSE
     statement_5
     [statement_6]]
.
.
END IF
```

or

```
IF boolean_expression THEN statement_1 [ELSE statement_2]
```

• Effect

This statement block allows conditional execution or branching, based on the evaluation of a Boolean expression.

• Comments

In the single-line variation of IF...THEN...ELSE, *statement_1* is executed if *boolean_expression* evaluates to true. If *boolean_expression* is false, then *statement_2* is executed. If ELSE is not present and *boolean_expression* is false, the program resumes execution on the line after the IF...THEN statement.

If there are any statements after the THEN the single line form is used and no END IF is required.

Thus the following is illegal:

```
IF a THEN PRINT "line 1"
    PRINT "line 2"
END IF
```


whereas

```
IF a THEN
    PRINT "line 1"
    PRINT "line 2"
END IF
```

is correct.

• See

SELECT.

• Example

```
S!=RND
IF S!<0.5 THEN
    PRINT "S! is smaller than 0.5"
ELSEIF S!>0.5 THEN
    PRINT "S! is larger than 0.5"
ELSE
    PRINT "S! is equal to 0.5"
END IF
```

INCR statement

• Syntax

INCR *numeric-variable*

• Effect

This statement adds one to the *numeric_variable*.

• Comments

The *numeric_variable* may be a simple or array variable of any numeric type, the value of which is incremented by one.

• See

DECR.

• Example

```
INCR a(i,j) 'equivalent to a(i,j)=a(i,j)+1
```


INKEY$ function

• Syntax

INKEY$

• Effect

This function reads a character from the keyboard without echo, if one is available.

• Comments

INKEY$ returns either a null, one- or two- byte string containing the character read from the keyboard.

A null string result (i.e. "") means no key was pressed.

A one-character string means a 'normal' key was pressed, and contains the ASCII value of it.

A two-character string means a non-ASCII key was pressed, whose scan code can be found in the second character - the first character will be CHR$(0). Keys such as the function keys, cursor keys, and Alt-combinations are non-ASCII.

• See

evnt_keybd AES function.

• Example

```
'This block provides a quicker way of processing user
'input, if only one character is needed.
PRINT "Enter your choice (1 or 2)"
DO
    a$=INKEY$
    SELECT CASE a$
        CASE ="1"
            CALL One: EXIT DO
        CASE ="2"
            CALL Two: EXIT DO
    END SELECT
LOOP
```

INP function

• Syntax

INP(*BIOS_handle*)

• Effect

This function returns a byte value from the device specified by *BIOS_handle*.

• Comments

INP is the complement of the OUT function. It waits for a byte from the specified device then returns its value.

BIOS_handle is defined as:

0	parallel port
1	serial port
2	keyboard
3	MIDI interface

The status of the device can be polled by using a negative value for *BIOS_handle*. A returned value of 0 indicates no character is available; -1 indicates that a character is available. The argument and result are both integers.

If the keyboard is read (2) and the bottom eight bits would be zero, then the value returned is the high word of the result with bit 7 set. This strange behaviour is provided for compatibility with ST BASIC which used this 'fudge' to return information about the function keys etc whilst still using a short integer. In general we recommend calling the BIOS BConin or AES evnt_keybd routines directly for this.

• See

OUT, evnt_keybd AES function, conin& BIOS function.

• Example

```
Listen:
IF INP(-3) THEN
    CALL MIDI_rd
ELSE GOTO Listen
.
.
SUB MIDI_rd
    Char%=INP(3)
.
.
```


INPUT statement

• Syntax

INPUT [;]["*prompt*"{;|,}] *variable_list*

• Effect

This statement prompts the user for input which is assigned to *variable_list*.

• Comments

INPUT causes program execution to halt and await user data. If a *prompt* is included, INPUT will first print it and then a question mark. If the question mark is to be suppressed, a comma should be put after *prompt*. If the cursor is to stay on the same line even after user presses enter (i.e. not echo the CR-LF), a semi-colon should be put immediately after the INPUT statement.

• See

INKEY$, evnt_keybd, INP, PRINT.

• Example

```
INPUT "The square of",Val%
PRINT "is";(Val%*Val%)
```

Result:

```
The square of 2 is 4
```

INPUT# statement

• Syntax

`INPUT #channel_number,variable_list`

• Effect

This statement reads data from the device or file specified by *channel_number* and assigns it to *variable_list*.

• Comments

The *channel_number* is the number specified when OPENing the file.

The data read must be numeric for numeric variables and leading carriage returns, line feeds, and spaces are ignored; the first character that is not one of the three preceding types is considered to be the beginning of a number. A number is terminated by space, carriage-return or a line feeds. If end-of-file is reached while a value is being read, the variable is terminated.

• See

BLOAD, INPUT$, PRINT#, Fread (GEMDOS call).

• Example

```
INPUT #1, Str$, Int%, Lng_int&, Sing!, Dub_float#
```


INPUT$ statement

• Syntax

`INPUT$(n[,[#]channel_number])`

• Effect

This statement reads *n* characters from the specified channel.

• Comments

If *channel_number* is omitted, the characters are read from the keyboard without echo. This can be used for input similar to INKEY$, but with a fixed amount of characters to be processed from the keyboard. *n* may be an integer or long integer. Thus assuming there is sufficient memory available an entire file can be read with one use of this function.

• See

BLOAD, INPUT, PRINT#, Fread (GEMDOS call).

• Example

```
'This program checks if DATA.PRG has the valid GEMDOS
'program header beginning.
OPEN "A.PRG" FOR INPUT AS #1
first%=CVI(INPUT$(2,#1))
CLOSE #1
IF first%=&H601A
    PRINT "This file is executable."
ELSE
    PRINT "This is not a valid GEMDOS program file!"
END IF
```

INSTR function

• Syntax

INSTR([*start*,]*1st_string*,*2nd_string*)

• Effect

This function searches backwards for the occurrence of *2nd_string* in *1st_string*.

• Comments

start is an optional offset for the beginning of the search within *1st_string*. *start* may be either an integer or a long integer. The strings may be either string-variables, string-literals, or string expressions. The value returned is the position of the first character of the string that has been found.

If *2nd_string* is found in *1st_string* the location where it was found is returned.

If *start* is a value larger than the length of *1st_string*, 0 is returned.

If the *1st_string* is a null string, 0 is returned.

If *2nd_string* cannot be found, 0 is returned.

If *2nd_string* is a null string, *start* is returned; if *start* was not specified, 1 is returned.

Note: As strings in HiSoft BASIC have no length limits this function returns a long integer.

• See

RINSTR.

• Example

```
'This routine parses the command line for a space to
'find the first parameter passed to the program.
I%=INSTR(COMMAND$," ")
IF I%=0 THEN I%=LEN(COMMAND$)
PRINT "The 1st parameter passed is: ";LEFT$(COMMAND$,I%)
```


INT function

• Syntax

INT(*numeric_expression*)

• Effect

This function returns the largest integer less than or equal to the *numeric_expression*.

• Comments

The value returned is the same type as *numeric_expression*.

• See

FIX, CINT, CDBL, CSNG, CDBL.

• Example

```
'This example illustrates the differences between the
'functions CINT, FIX and INT.
PRINT CINT(1.5),CINT(-1.5)
PRINT FIX(1.5),FIX(-1.5)
PRINT INT(1.5),INT(-1.5)
```

Result:

```
2         -2
1         -1
1         -2
```

KILL statement

• Syntax

KILL *file_spec*

• Effect

All files fitting the description of *file_spec* are deleted from disk.

• Comments

The *file_spec* must conform to the GEMDOS format. KILL will not delete directories from disk, only their contents; use RMDIR to delete the actual directory.

• See

Fdelete GEMDOS function.

• Example

```
KILL "C:\BASIC\*.BAS"    'This line deletes all files
            'with the extension BAS in the
            'sub-directory BASIC on drive
            'C: This is probably not what
            'you want!
```


LBOUND function

• Syntax

LBOUND(*array*[,*dimension*])

• Effect

This function returns the smallest available subscript of the specified array and optionally of a specific dimension.

• Comments

A common use of LBOUND is to determine the size of an array, together with UBOUND. *array* is the array to be checked, whereas *dimension* is the number of the dimension to be checked.

In fact because OPTION BASE is used for all the subscripts of the array they will all have the same lower bound. However it may be possible to explicitly set the lower bound in the future.

• See

UBOUND, OPTION BASE.

• Example

```
DIM Levels(X,Y,Z)
.
.
PRINT LBOUND (Levels,2)'This will return the lowest
            'bound for the Y dimension
            'which is 0 unless otherwise
            'defined with OPTION BASE
```

LCASE$ function

• Syntax

LCASE$(*string_expression*)

• Effect

This function returns a string with every alphabetic character in lower case.

• Comments

Any characters in the range 'A' to 'Z' inclusive are converted to 'a' to 'z' as required. All other characters are left alone including accented letters.

• See

UCASE$, ASCII table.

• Example

```
PRINT "Do you wish to format your hard disk? Y/N";
DO a$=INKEY$
UNTIL a$<>""
IF LCASE(a$)="y" THEN
    do_format "C:"
ELSE
    PRINT "Very wise"
END IF
```


LEFT$ function

• Syntax

LEFT$(*string_expression,n*)

• Effect

This function returns a string made up of the leftmost *n* characters of *string_expression*.

• Comments

n is a long integer argument as there is no string length limit in HiSoft BASIC. If *n* = 0 then a null string is returned. If *n* is greater than the number of characters in *string_expression*, the entire string is returned.

string_expression may be a string variable, a string literal or a string constant.

• See

MID$, RIGHT$.

• Example

```
String$="HiSoft BASIC"
PRINT LEFT$(String$,6)
```

Result:

```
HiSoft
```

LEN function

• Syntax

`LEN(string_expression)`

• Effect

This function returns the number of characters in *string_expression*.

• Comments

string_expression may be a string variable, a string literal or a string constant. This can return numbers greater than 32767 so be careful if assigning to integers - use long integers instead.

• Example

```
Another_String$="DevpacST by HiSoft"
PRINT LEN(Another_String$)
```

Result:

18

LET statement

• Syntax

`[LET] variable = expression`

• Effect

Assigns *variable* the value of *expression*.

• Comments

LET is entirely optional and unnecessary; the equals sign is sufficient to assign values to variables. When assigning to a FIELDed variable you should use LSET or RSET.

• Example

```
LET profit=income-sales-tax
```

is the same as

```
profit=income-sales-tax
```

LIBRARY statement

• Syntax

LIBRARY *library_name*[,*another_library_name*]...

• Effect

This statement defines which libraries are to be used by the program.

• Comments

Libraries are additional functions and procedures written in assembly language but callable from HiSoft BASIC programs. The specified libraries must exist within the current HBASIC.LIB file. Library routines are called in exactly the same way as BASIC sub-programs and functions..

For details of the supplied libraries see *Chapter 2*. For information on writing your own libraries and general use of assembly language and C routines see *Appendix F*.

• See

DECLARE.

• Example

```
LIBRARY "xbios"
BLOAD "TOOTH.PIC",logbase&
```


LINEF statement

• Syntax

LINEF *x_start*,*y_start*,*x_end*,*y_end*

• Effect

Draws a line between two points in the current window.

• Comments

Both co-ordinates are specified relative to the top left of the window. The colour of the line can be specified using the COLOR statement.

Note that the co-ordinates are given relative to the current window, unlike the corresponding GEMVDI v_pline command.

• See

BAR, COLOR, v_pline GEMVDI routine.

• Example

```
FOR i=0 TO 300 STEP 3
    LINEF i,0,300-i,200
NEXT i
FOR i=0 TO 200 STEP 3
    LINEF 0,i,300,200-i
NEXT i
```

LINE INPUT statement

• Syntax

```
LINE INPUT[;] ["prompt";] string_variable
```

• Effect

This statement assigns an entire line of input to *string_variable* while ignoring delimiters (such as commas).

• Comments

The *prompt* is printed before input is awaited. A question mark will not be displayed unless it is part of *prompt*. If LINE INPUT is immediately followed by a semi-colon, the CR-LF marking the end of the input line will not be echoed to the screen.

LINE INPUT is more useful if you need to enter strings with commas, quotation marks or spaces in them.

• See

INPUT, READ, PRINT, WRITE.

• Example

```
LINE INPUT "Enter command:",Com$
```


LINE INPUT# statement

• Syntax

```
LINE INPUT #channel_number,string_variable
```

• Effect

This statement reads a sequence of characters terminated by a CR-LF from the device or file specified by *channel_number* and assigns it to *string_variable*.

• Comments

This statement will read a sequence up to, and including, a CR-LF, and return. A subsequent LINE INPUT# will begin reading the second sequence after the CR-LF.

The LINE INPUT# statement allocates a buffer when reading a line. By default this is 1024 bytes enabling you to read lines up to 1K in length. If you wish to increase this you can change the long integer pointed to by SYSTAB+68. In general it is best to read long strings using INPUT$ as this is much more efficient.

• Example

```
'This routine reads a file in which 5 records that are
'delimited by CR-LFs are kept.
DIM Record$(5)
OPEN "BASE.LST" FOR INPUT AS #1
I%=0
WHILE NOT EOF(1)
    I%=I%+1
    LINE INPUT #1,Record$(I%)
WEND
CLOSE #1

POKEL SYSTAB+68,2048    'increase the buffer to 2048
bytes.
```

LOC function

• Syntax

`LOC(channel_number)`

• Effect

This function returns the program's current position within an OPENed file.

• Comments

The value returned is a long integer. When used with random-access files, LOC returns the number of the last record read or written to the file. For sequential files opened for OUTPUT, INPUT or APPEND the value returned is the number of bytes written or read divided by 128.

• See

LOF, fseek GEMDOS call.

• Example

```
SUB WriteBlock
STATIC remember%
remember%=LOC(2)     'get current position
LSET a$=MKI$(remember%)
PUT #2,1             'use record 1 to hold last
                     'updated record number
PUT #2,remember      'and write actual record
END SUB
```


LOCAL statement

• Syntax

`LOCAL variable_list`

• Effect

This statement declares variables as local to function definitions and sub-programs and creates a new variable each time the function or sub-program is left and re-entered.

• Comments

This statement can be used only within function definitions and sub-programs.

Variables in DEF FN function definitions usually are global or STATIC in sub-programs and FUNCTIONs. The LOCAL statement ensures that a new variable is created every time a recursive sub-program or function is called. See the *User Manual : Concepts* chapter for more details. Note that the LOCAL statement for arrays also dimensions the array, there is no need for a separate DIM statement.

• Example

```
test=10
PRINT FNeasy,test
DEF FNeasy
STATIC test          'without this the global
test=5               'test would be changed here
FNeasy=1/test
END SUB
```

LOCATE statement

• Syntax

LOCATE *row*[,*column* [,*cursor*]]

• Effect

This statement puts the cursor on *column* and *row* specified; it can also enable or disable the cursor.

• Comments

If any parameter is omitted, LOCATE has no effect on that particular value.

column is the column number of the screen where the cursor is to be placed..

row is the row number on the screen where the cursor is to be placed.

If *cursor* is set to 0, the cursor is disabled; *cursor* set to 1 enables it.

The cursor is a small black rectangle, usually flashing when in a TOS program. For maximum speed the BASIC I/O system disables the cursor during character output. A cursor will always be shown when entering text via an INPUT statement regardless of its current setting.

If LOCATE is used within a window the range of *row* and *column* is determined by the current window size.

• See

POS, CSRLIN.

• Example

```
LOCATE 1,1,0     'this line moves the cursor to
                 'the upper left corner of the
                 'screen and disables the cursor.
```


LOF function

• Syntax

LOF(*channel_number*)

• Effect

This function returns the length of the file specified by *channel_number*.

• Comments

The value returned for the open file is a long integer.

• See

LOC,Fseek GEMDOS call.

• Example

```
'This routine opens a file, checks its length, allocates
'enough memory, and reads it in its entirety.
OPEN "LOTSA.INF" FOR INPUT AS #1
Length&=LOF(1)
FileBuf$=INPUT$(Length&,#1)
CLOSE #1
```

LOG, LOG10, LOG2 functions

• Syntax

LOG(*numeric_expression*)
LOG10(*numeric_expression*)
LOG2(*numeric_expression*)

• Effect

LOG returns the natural logarithm (base *e*) of *numeric_expression*.

LOG10 returns the logarithm base 10 of *numeric_expression*.

LOG2 returns the logarithm base 2 of *numeric_expression*.

• Comments

numeric_expression must be greater than 0.

e is approximately 2.718281828459046

All logarithmic functions are evaluated with single-precision accuracy by default. If the *numeric_expression* is a double-precision number, LOGtype will calculated in double-precision.

• See

EXP, ^ operator in the *User Manual : Concepts* chapter.

• Example

```
PRINT LOG10(10),LOG10(5)
```


LPOS function

• Syntax

LPOS(*argument*)

• Effect

This function returns the number of characters printed via LPRINT since the last CR/LF..

• Comments

The actual physical position of the printer head is not necessarily returned, as tabs are not expanded. The value returned is the position within the printer buffer starting at 1.

argument is a dummy parameter.

• See

POS, LPRINT.

• Example

```
'This routine continues printing strings until the
'printer head reaches the 50th column
WHILE LPOS(0)<50
    I%=I%+1
    LPRINT String$(I%)
WEND
```

LPRINT, LPRINT USINGstatements

• Syntax

```
LPRINT [expression_list][{;|,}]
LPRINT USING format_string; expression_list [{;|,}]
```

• Effect

These statements print data through the current printer port.

• Comments

LPRINT and LPRINT USING are analogous to PRINT and PRINT USING, except that the data output is via the current printer port. Normally this is the parallel port but this can be changed using the Install Printer desk accessory, supplied on the Atari system disk or the Atari Printer CPX.

• See

PRINT, LPRINT USING, PCOPY.

• Example

```
LPRINT CHR$(12);     'This line send a form-feed to
                     'the device connected to the
                     'printer port.
```


LSET statement

• Syntax

```
LSET string_variable = string_expression
```

• Effect

Left-justify a string variable, normally used for FIELDed variables.

• Comments

LSET left-justifies a string variable by padding with spaces on the right up to its length. This is normally used for FIELDed string variables, but can be used with ordinary string variables for formatting output. RSET is similar except that it right-justifies.

• See

FIELD, RSET, PUT.

• Example

```
FIELD #2,20 AS a$
LSET a$=GetData$(10)
PUT #2
```

LTRIM$ function

• Syntax

LTRIM$(*string_expression*)

• Effect

This function returns its string parameter with any leading spaces removed.

• Comments

LTRIM$ trims spaces from the left. of a string This can be used to remove spaces at the beginning of user input.

• See

RTRIM.

• Examples

```
commandline$=LTRIM$(COMMAND$)
' commandline$ won't have spaces at the front

PRINT LTRIM$("   HiSoft")
PRINT LTRIM$("BASIC")
```

Result:

```
HiSoft
BASIC
```


MAX function

• Syntax

MAX(*expression*,*expression* [,*expression*]…)

• Effect

Finds the maximum of two or more values..

• Comments

MAX finds the largest of any number of expressions. The expressions may be of any numeric type or may all be strings.

• Example

```
INPUT "Enter three names";a$,b$,c$
PRINT "The first is ";MIN(a$,b$,c$)
PRINT "The last is ";MAX(a$,b$,c$)
```

MID$ function

• Syntax

MID$(*string_expression*,*n*[,*length*])

• Effect

This statement returns *length* characters from *string_expression* starting at the *n*th character.

• Comments

If there are fewer than *length* characters in *string_expression*, or if there are fewer than *length* characters to the right of the *n*th character, all characters following the *n*th character are returned. If there are less than *n* characters in *string_expression* , a null string is returned.

• See

RIGHT$, LEF$, SADD.

• Example

```
Sentence$="This is HiSoft BASIC"
PRINT MID$(Sentence$,9,6)
```

Result:

```
HiSoft
```


MID$ statement

• Syntax

MID$(*string_variable*,*n*[,*length*])=*string_expression*

• Effect

Modifies part of a string variable.

• Comments

The characters of *string_variable* starting at position *n* are modified to be the characters of the *string_expression*. If *length* is specified then only this number of characters are replaced; otherwise the whole of *string_expression* is used.

MID$ cannot be used to change the length a string and as a result is more efficient than an equivalent assignment statement. The *string_variable* may be a simple string variable or an element of a string array. Both *n* and *length* may be integers or long integers.

• See

LSET, RSET.

• Example

```
SentenceS="This is HiSoft BASIC"
MID$(Sentence$,1)=" It was"
PRINT Sentence$
```

Result:

```
 It was HiSoft BASIC
```

MIN function

• Syntax

`MIN(`*expression*`,`*expression* `[,`*expression*`]…)`

• Effect

Finds the minimum of two or more values..

• Comments

`MIN` finds the least of any number of expressions. The expressions may be of any numeric type or may all be strings.

• Example

```
INPUT "Enter three values";a,b,c
PRINT "The smallest is ";MIN(a,b,c)
```


MKDIR statement

• Syntax

`MKDIR` *pathname*

• Effect

This statement creates the sub-directory as specified by *pathname*.

• Comments

pathname must conform to the GEMDOS format conventions.

`MKDIR` can also be used with relative as well as absolute *pathnames*. For a detailed explanation of this, please refer to `CHDIR`.

• See

`CHDIR`, `CURDIRS`, `RMDIR`, `Dcreate` GEMDOS call.

• Example

```
MKDIR "\ONE"      'an absolute pathname
CHDIR "\ONE"
MKDIR "TWO"       'this is a relative pathname;
                  'it creates \ONE\TWO
```

MKI$,MKL$,MKS$,MKD$ functions

• Syntax

```
MKI$(integer_expression)
MKL$(long_integer_expression)
MKS$(single_precision_expression)
MKD$(double_precision_expression)
```

• Effect

These functions convert numeric data of the *expression*s into strings.

• Comments

These functions take a numeric value and store it in a string variable. There is no conversion into human readable form. These functions are often used before outputting numeric data via LSET and RSET; both of these are only able to process strings. It is vital to note that these functions are not interchangeable with STR$. A numeric value processed by a MKtype$ function and then printed will be a binary representation of the number.

• See

CVI, CVD, CVS, CVL, FIX, INT, STR$.

• Example

```
OPEN "FLD.DAT" AS #1
FIELD #1, 4 AS Lint$          'defines a field
Longint&=65536
LSET Lint$=MKL$(Longint&)     'puts the string value into
                              'the record
PUT #1,1                      'record is written to file
CLOSE #1
```


MOUSE function

• Syntax

```
MOUSE(attribute)
```

• Effect

Read the current position of the mouse and the status of the buttons and keyboard shift keys.

• Comments

The value returned is an integer, the interpretation of which depends on the *attribute*:

0	X position of mouse
1	Y position of mouse
2	button state, 0=none, 1=left, 2=right, 3=both pressed
3	keyboard shift state
4	Xposition of STE paddle 0
5	Y position of STE paddle
6	Xposition of STE paddle 1
7	Y position of STE paddle 1
8	Xposition of STE light pen in screen pixels
9	Y position of STE light pen in screen pixels

Note that the mouse X and Y positions are relative to the screen top-left, not to any windows.

The keyboard shift state is returned as the sum of the following numbers:

1	right Shift
2	left Shift
4	Control key
8	Alt key

For example if both shift keys were held down the result of MOUSE(3) would be 3.

Note that the STE routines require the STE hardware - if it isn't there the machine will probably crash.

• See

vq_mouse & vq_key_s GEMVDI calls.

• Example

```
WINDOW FULLW
CLS
DO                          'plot points with left button
    IF MOUSE(2)=1 THEN PSET(MOUSE(0),MOUSE(1))
LOOP UNTIL MOUSE(3)=8    'until Alt key held down
```


MOUSE statement

• Syntax

MOUSE *mouse_type*

• Effect

Set the mouse to a pre-defined form or remove it from the screen.

• Comments

If *mouse_type* is -1 then the mouse is hidden from the screen, useful for example just before BLOADing a screen image or to increase the speed of screen output.

If *mouse_type* is not -1 then the appearance of the mouse is changed to one of the following:

0	normal arrow
1	vertical bar-like cursor
2	'busy' bee
3	hand with pointing finger
4	outstretched hand
5	thin cross
6	thick cross
7	outlined cross

• See

graf_mouse AES call.

• Example

```
MOUSE -1
load_picture
MOUSE 4
drag_picture
```

NAME statement

• Syntax

NAME *old_filename* AS *new_filename*

• Effect

This statement renames the file specified by *old_filename* to *new_filename*.

• Comments

Both file specifications must conform to the GEMDOS format. Unlike Microsoft BASIC under MS-DOS you cannot move files between directories by renaming them. Both arguments are string expressions.

• See

KILL, Frename GEMDOS call.

• Example

```
NAME "AFILE.BAS" AS "ANOTHER.BAS"
```


OCT$ function

• Syntax

OCT$(*numeric_expression*)

• Effect

This function returns a string which is the octal representation of *numeric_expression*.

• Comments

OCT$ returns the representation of the integer part of *numeric_expression*. If the expression is an integer then the resulting string will be from 1 to 6 characters in length, but if it is a long integer then it can be up to 11 characters long.

• See

BIN$, HEX$

• Example

```
PRINT OCT$(8).
```

Result:

```
10
```

ON ERROR statement

• Syntax

ON ERROR GOTO {*linenumber*|*linelabel*}

• Effect

Enable error handling and specify error handling routine.

• Comments

This command allows you to trap run-time errors such as overflow or disk full and pass control to a specific BASIC line if any errors occur. The error handler *must* be at the main level of your program - it cannot be within a sub-program or function.

If a line number of 0 is specified, any error handling is disabled and subsequent errors will abort program execution in the normal way. If ON ERROR GOTO 0 is specified within an error handler it will cause the original error message to be printed and program execution will be halted.

If you wish program execution to continue after an error you should use the RESUME statement.

Use of ON ERROR in a program causes a larger program size and slightly slower execution speed due to the saving of extra information while a program runs.

• See

RESUME, ERL, ERR.

• Example

```
ON ERROR GOTO handler
OPEN "DATA.INF" FOR INPUT AS #2
INPUT LINE #2,a$
CLOSE #2
PRINT "Data is ";a$ : STOP
handler:
IF ERR=53 THEN
    PRINT "Error - File DATA.INF not found" : STOP
ELSE
    ON ERROR GOTO 0 'another error so report
END IF
```


ON...GOSUB statement

• Syntax

ON *n* GOSUB {*linenumber*|*linelabel*}
    [,{*linenumber*|*linelabel*...}]...

• Effect

This statement calls one of a list of subroutines depending on the value of a parameter.

• Comments

If *n* has a fractional part it will be rounded to an integer.

n determines which *label* is jumped to. If *n* is 1 then the first subroutine is GOSUBed, else if *n* is 2 then the second label is the the subroutine that is executed, and so on for all the given subroutines.

If *n* is less than 1 or greater than the number of subroutines available, program execution continues after the ON...GOSUB statement.

It is normally best to use a SELECT CASE statement and sub-program calls rather than ON...GOSUB.

• See

SELECT...CASE, ON_GOTO.

• Example

```
ON Number% GOSUB One-routine, Two_routine, Three_routine
'If Number% = 3 then Three-routine will be executed.
```

ON...GOTO statement

• Syntox

```
ON n GOTO {linenumber|label} [,{linenumber|label}]…
```

• Effect

This statement causes program execution to branch to one of a list of program lines depending on the value of a parameter.

• Comments

This statement differs from ON...GOSUB in that program execution does not return to the line after this statement.

If *n* has a fractional part then it will be rounded to an integer.

n determines which label is jumped to. If *n* is greater than the number of labels specified, or if *n* is less than 1, program execution continues after the ON...GOTO statement.

We recommend using the SELECT CASE statement in preference to ON...GOTO.

• See

SELECT...CASE, ON...GOSUB.

• Exomple

```
ON Number% GOTO One_branch, Two_branch, Three_branch
'If Number% = 1 then program execution will continue at
'One_branch.
```


OPEN statement

• Syntax

```
OPEN file_spec [FOR mode] AS [#]channel_num
     [LEN=record_size]
```

or

```
OPEN mode_string, [#]channel_num, file_spec [,record_size]
```

• Effect

This statement prepares a file for reading or writing.

• Comments

file_spec must conform to GEMDOS specifications.

mode may be one of the following:

APPEND	Specifies a sequential file which is to be appended
INPUT	Specifies a sequential file which is to be read from
OUTPUT	Specifies a sequential file which is to be written to
RANDOM	Specifies a random-access file to be read from or written to

mode_string is a string expression of one character which is the first letter of the *mode* of the file (A, I, O or R), in upper- or lower-case.

channel_num may be any integer value from 1 to 255 inclusive.

record_size specifies the length of each record in bytes in a random-access file, or the internal buffer size for other types of file. The default value for *record_size* is 128 bytes.

OPEN associates a file or device with *channel_num*. This number is used in all read or write operations to access the file or device.

The counterpart to OPEN is CLOSE. It is a good idea to CLOSE a file whenever possible and reOPEN it later if necessary. This is a safety measure; if the system should go crazy for some reason, any data which is still in a buffer will be lost and the file may very well later contain garbage.

Normally file_spec refers to a disk file, but there are certain device names that may also be used. These names are:

CON:	screen and keyboard
PRT:	parallel printer port
AUX:	RS232 port
LST:	current printer port as chosen with *Install Printer*
MID:	MIDI port
KBD:	Intelligent keyboard

Note that channels opened with these names will only respond to simple input/output, that is PRINT#, WRITE# INPUT# and INPUT$. Random access operations and other operations (such as LOF;) ,that do not make sense on non-disk devices, will not work. Care should be taken when opening the CON: device as if in GEM mode the window contents will be lost and if in TOS mode output from PRINT statements will become mixed up with output from PRINT#.

If you use OPEN on a channel that is already open the old file will be closed before the new one is opened. If the file was opened for random access any associated FIELDed variables will be cleared

• See

CLOSE, Fopen & FClose GEMDOS calls.

• Example

```
OPEN "RECORDS.RAN" FOR RANDOM AS #1 LEN=32
'This line opens the random-access file RECORDS.RAN for
'reading & writing, associates it with #1 and specifies
'the record length to be 32 bytes.
'the next line does the same using the alternate syntax
'except using #2
OPEN "R",#2,"RECORDS.RAN",32
```


OPTION BASE statement

• Syntax

```
OPTION BASE {0|1}
```

• Effect

This statement defines the lowest subscript value of arrays.

• Comments

OPTION BASE sets the subscript value of the first element in an array. For instance, an OPTION BASE 1 before DIM Array%(42) causes 42 elements (1-42) to be allocated, not the default 43 (0-42).

Using OPTION BASE 1 saves hardly any space unless you are using three or higher dimension arrays.

Note that if the Array Checks option is off when a program is compiled, OPTION BASE statements are ignored and OPTION BASE 0 is assumed.

• See

DIM.

• Example

```
OPTION BASE 0       'this is default
DIM Another_array%(177)     '178 elements will be
            'allocated, 0 to 177
```

OUT statement

• Syntax

`OUT BIOS_handle, integer_expression`

• Effect

This statement sends a byte to the BIOS output routines.

• Comments

BIOS_handle may have the following values:

0	Parallel port
1	Serial port
2	Console
3	MIDI
4	Intelligent keyboard controller
5	Direct screen output

The range of the byte sent to the port is 0 to 255.

If you send bytes directly to the screen or printer using OUT you can confuse the BASICs idea of where the cursor is, for example.

Do not attempt to send bytes to the keyboard controller unless you are very sure what you are doing.

• See

INP, BConout BIOS routine.

• Example

```
PRINT "This action is ";
OUT 2,27: OUT 2,"p"%    'reverse video
PRINT "VERY DANGEROUS";
OUT 2,27: OUT 2,"q"%    'normal video
```


PALETTE statement

• Syntax

`PALETTE [colour_number,physical_colour]`

or

`PALETTE USING array_element`

• Effect

This statement allows you to change the physical appearance of colours on the screen.

• Comments

Each colour on the ST can have its actual appearance changed on screen by changing the colour palette. If no parameters are given all colours are restored to their normal defaults, as shown in the table under the COLOR command. *colour_number* should be an integer from 0 to 15, that corresponds to the colour you wish to change. The *physical_colour* is the value to be placed into the register, in the form of three hex digits in the range 0 to 7, one for red, one for green, and one for blue.

To use the extended palette range of the TT and STE with this statement, the hex digits can also include 8 to F but in order to maintain compatibility they are mapped in the following way:

STE	0	8	1	9	2	A	3	B	4	C	5	D	6	E	7	F
Intensity of gun	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ST	0		1		2		3		4		5		6		7	

The PALETTE USING command takes an array as a parameter and uses all the elements in the array and loads them into each colour.

We recommend using the GEMVDI v_color routine as this lets you set the palette in a machine independent way without the complexity of the mapping above. You can also easily use the 256 colours of TT Low Resolution with this call, whereas to use the hardware directly you need to use the Esetpalette XBIOS routine.

• See

vs_color VDI routine, setcolor, setpalette, esetcolor, esetbank, esetpalette BIOS routines

• Example

```
PALETTE              'reset to default
PALETTE USING a%(0)  'set them up
PALETTE 0,&h701      'make white into red with
                     'a little blue

INPUT "Invert screen";a$    'monochrome only
IF UCASE$(a$)="Y" THEN
    PALETTE 0,0      'make white=black
ELSE
    PALETTE 0,&h777  'make white=white
END IF
```


PCIRCLE statement

• Syntax

PCIRCLE *x_centre*,*y_centre*,*radius*[,*start_angle*,*end_angle*]

• Effect

Draws a solid circle or arc in the current window.

• Comments

If the optional angle parameters are omitted, the command draws a filled circle with an outline and fills it with the current fill colour, index and style attributes set with COLOR. The angle parameters are expressed in degrees times 10, and are measured anti-clockwise starting on the right side. Hollow circles and arcs can be drawn using the CIRCLE command. All the parameters are integers.

The *x_centre* and *y_centre* are relative to the current window rather than the screen. PCIRCLE ensures that the x radius and y radius are the same in pixels. As a result the graphic that is drawn will not appear circular in some resolutions (e.g. ST Medium) where the pixels are not square. To draw circles that look like circles but which will have different y-radii use the GEMVDI v_circle command and then fill that circle.

• See

PELLIPSE, CIRCLE, BAR, v_circle, v_ellipse, v_ellpie (VDI routines).

• Example

```
COLOR 1,1,1,6,2
PCIRCLE 200,100,50
```

PCOPY statement

• Syntax

PCOPY

• Effect

Dump the current screen to a printer.

• Comments

This has the same effect as pressing Alt-Help, and may be interrupted by pressing the same key combination.

• See

LPRINT.

• Example

```
IF a$="C" THEN
    MOUSE -1      'hide mouse
    PCOPY         'and dump screen
END IF
```


PEEK function

• Syntax

PEEK(*address*)

• Effect

This function returns a byte, word or long of the contents at location *address*.

• Comments

In general we recommend the use of the PEEKB, PEEKW, PEEKL, SPEEKB, SPEEKW or SPEEKL functions and their POKE counterparts rather than the use of DEF SEG, PEEK and POKE which are provided for ST BASIC compatibility. The new style statements are faster and easier to understand.

The length of the returned value (byte, word or long) depends on the DEF SEG statement.

If DEF SEG > 0 then 1 byte is PEEKed and the value of the *address* is added to the DEF SEG value.

If DEF SEG = 0 and the *address* given to PEEK is of type single or integer then 2 bytes are PEEKed from address.

If DEF SEG = 0 and the *address* passed is of type long integer or double, then 4 bytes are PEEKed.

This differs from the PEEKB, PEEKW and PEEKL statements in that it can read protected memory areas and words from odd addresses, but is much slower as a result.

• See

POKE, PEEKB, PEEKW, PEEKL, SPEEKB, SPEEKW, SPEEKL.

• Example

```
DEF SEG 0
PRINT PEEK(&H4A6)    'This returns the number of floppy
                     'disk drives connected
```

PEEKB, PEEKL, PEEKW functions

• Syntax

```
PEEKB(address)
PEEKL(even_address)
PEEKW(even_address)
```

• Effect

These functions return the contents of the memory specified.

• Comments

PEEKB returns one byte, PEEKW returns a word (16-bit) and PEEKL returns a long (32-bit). When using PEEKL or PEEKW, the address specified must be even, otherwise an address error (3 bombs) will occur unless you are running on a machine with at least a 68020 processor.

These functions are only able to read memory within user memory. Any read which requires supervisor mode or of non-existent memory will result in a bus error (2 bombs).

These functions are supplied as fast ways of reading user memory. For this reason, no checks are made as to the even-ness of the addresses for PEEKL and PEEKW; the same reason applies to no checks for reads of supervisor memory. To read from supervisor memory use the SPEEKB, SPEEKW and SPEEKL functions.

PEEKB and PEEKW return integers; PEEKL returns a long integer.

• See

SPEEKB, SPEEKW, SPEEKL, POKEB, POKEW, POKEL.

• Example

```
Seven%=7
PRINT PEEKW(VARPTR(Seven%))
```

Result:

```
7
```


PELLIPSE statement

• Syntax

```
PELLIPSE x_centre,y_centre,x_radius,y_radius
    [,start_angle,end_angle]
```

• Effect

Draws a solid ellipse or elliptical arc in the current window.

• Comments

If the optional angle parameters are omitted, the command draws a solid ellipse in the current fill colour, index and style. The angle parameters are expressed in degrees times 10, and are measured anti-clockwise starting on the right side. Hollow ellipses and arcs can be drawn using the ELLIPSE command. All the parameters are integers.

The *x_centre* and *y_centre* are relative to the current window rather than the screen. unlike the corresponding v_ellpie VDI command.

• See

PCIRCLE, ELLIPSE, v_ellpie GEMVDI command.

• Example

```
COLOR 1,1,1,19,2
PELLIPSE 200,100,100,30
COLOR 1,1,1,4,2
PELLIPSE 200,100,80,25,0,1800
```

POINT function

• Syntax

POINT(*x_pixel*,*y_pixel*)

• Effect

This function returns the colour of a particular pixel.

• Comments

x_pixel and *y_pixel* specify the coordinates within the current output window of the pixel to be read. The result corresponds to the table shown under the description of COLOR.

If the required pixel is not within the window, a result of -1 is returned.

• See

PSET, PRESET, LINEF.

• Example

```
COLOR 1,1,1,6,2
PRINT "B"
FOR x=0 to B
FOR y=0 to 16
IF POINT(x,y) THEN BAR 10*(x+1),10*(y+2),10,10
NEXT y,x
```


POKE statement

• Syntax

POKE *address*,*data*

• Effect

This statement writes *data* directly to *address* in memory.

• Comments

In general we recommend the use of the POKEB, POKEW, POKEL, SPOKEB, SPOKEW or SPOKEL functions and their PEEK counterparts rather than the use of DEF SEG, PEEK and POKE which are provided for ST BASIC compatibility. The new style statements are faster and easier to understand.

The size of *data* that is written is dependent on the last DEF SEG statement. DEF SEG is zero by default.

If DEF SEG > 0 then 1 byte is POKEd and the value of the *address* is used as an offset of the value of DEF SEG.

If DEF SEG = 0 and the *address* given to POKE is of type single or integer then 2 bytes POKEd.

If DEF SEG = 0 and the *address* passed is of type long integer or double, then 4 bytes are POKEd.

POKE is a good deal slower than POKEB, POKEW and POKEL but is able to write to protected or non word-aligned locations. Note that the value POKEd does not depend on the *data* but on the *address*.

• See

PEEK, POKEB, POKEW, POKEL, SPOKEB, SPOKEW, SPOKEL.

• Example

```
DEE SEG 0        'POKE a word
POKE &H484,14    'this turns off the keypress click
```

POKEB, POKEL, POKEW statements

• Syntax

```
POKEB address, byte_value
POKEL even_address, long_value
POKEW even_address, word_value
```

• Effect

These statements write data directly into memory.

• Comments

These statements are very much faster than POKE. They can not POKE into supervisor memory, nor do they check for even addresses for POKEL and POKEW.

POKEtype into supervisor memory will cause a bus error (2 bombs). To poke into such memory use the SPOKEtype commands.

POKEL or POKEW to an odd address will result in an address error (3 bombs).

• See

POKE, POKEB, POKEW, POKEL, SPEEKB, SPEEKW, SPEEKL.

• Example

```
Ten%=10
POKEW VARPTR(Ten%),7
PRINT Ten%
```

Result:

```
 7
```


POS function

• Syntax

```
POS(x)
```

• Effect

This function returns the column number of the current cursor position.

• Comments

x is a dummy argument and serves no purpose. The value returned is the column (horizontal position) of the cursor, the leftmost position being 1. *x* should be numeric.

• See

LPOES, LOCATE, PRINT.

• Example

```
x%=POS(0)
PRINT "The cursor was in column";x%
```

PRESET statement

• Syntax

PRESET [STEP] (*x_pos*,*y_pos*) [,*colour*]

• Effect

This statement resets or sets a pixel to a given colour in the current window.

• Comments

PRESET is similar to PSET, except that if the *colour* parameter is omitted the background (or fill) colour is used. The parameters *x_pos* and *y_pos* specify the pixel set, relative to the top left of the current window. If the optional STEP keyword is specified then the co-ordinates are taken relative to the last PSET or PRESET co-ordinates.

• See

PSET, POINT, LINEF, v_pline GEMVDI routine.

• Example

```
CONST ypos=70
DEFINT i
FOR i=10 TO 350
    IF i<300 THEN PSET (i,ypos)
    IF i>50 THEN PRESET (i-50,ypos)
NEXT i
```


PRINT statement

• Syntax

PRINT [*expression_1*][{;| |,}*expression_2*][;]…

• Effect

This statement prints the data defined in the list of expressions on the screen.

• Comments

The list of expressions may contain a series of string and/or numeric expressions. These expressions must be separated with semi-colons, commas or spaces. If the list of expressions does not end in a semi-colon or a comma, a CR-LF will be output.

A PRINT by itself will cause a CR-LF.

A semi-colon separating expressions will cause them to be printed without a space between them. A space between parameters has the same effect as a semi-colon. We recommend using a semi-colon. A comma will cause the expression after the comma to be printed at the next tab stop.

SPC and TAB may be used in PRINT statements, but not elsewhere.

Numbers are printed with either a leading space (if positive) or minus sign, and always with a trailing space.

A question-mark may be substituted for PRINT if absolutely necessary; this is a feature of some older BASIC interpreters. To enhance compatibility with other BASICs, we have included this option as well.

PRINT in TOS mode gives 80 columns by 25 rows in ST High and Medium resolutions.

PRINT in GEM mode gives rather fewer characters, firstly because of the space taken by the menu bar and window title and scroll bars. You can 'reclaim' this space by using WINDOW FULLW. The second reason for fewer characters on the screen is that, for compatibility with older BASICs, HiSoft BASIC leaves a margin of one pixel at the top and bottom of each window and a gap of one pixel between each line.

You can remove these using the SYSTAB function as follows:

```
' decrease character height
POKEW SYSTAB+38,PEEKW(SYSTAB+38)-1
POKEL SYSTAB+72,0    ' make both margins 0
```

• See

OUT, LPRINT, PRINT #, PRINT USING, WRITE.

• Example

```
PRINT "The range is";1;"to";100,"(inclusive)"
```

Result:

```
The range is 1 to 100   (inclusive)
```


PRINT#, PRINT# USING statements

• Syntax

```
PRINT #channel_num, [USING
    format_string] expression_list [;]
```

• Effect

These statements write formatted data to a file or device.

• Comments

channel_num is the number specified when the file was opened.

format_string is an optional string of formatting characters. For an explanation of these, please refer to the PRINT USING entry.

expression_list is the list of string and/or numeric expressions to be written.

PRINT# writes the data exactly the way PRINT would to the screen. For this reason, great care should be taken to format the data written so that it is recognisable for a later INPUT#.

• See

PUT, WRITE, INPUT#, FORMATx$.

• Example

```
FOR I%=1 TO 5
PRINT #1,I%;",";
NEXT I%
```

Result: (in the target file)

```
 1 , 2 , 3 , 4 , 5 ,
```

PRINT USING statement

• Syntax

`PRINT USING format_string; expression_list [{,|;}]`

• Effect

This statement prints `expression_list` according to the format specified by `format_string`.

• Comments

`expression_list` contains the expressions (numeric or string) that are to be printed; they must be separated by semi-colons.

`format_string` is a string of formatting characters which determine the field and format of the expressions to be printed.

There are three format characters available for formatting strings:

- `!` This specifies that only the first character of the string is to be printed.
- `\ \` These specify that 2 + *n* characters of the string are to be printed. *n* is the number of spaces between the backslashes. If the string is longer than 2 + *n*, the extra characters are not printed. If 2 + *n* is larger than the number of characters in the string, the string will be printed left-justified with spaces padding the right.
- `&` This specifies a variable length field; if the ampersand (&) is the `format_string`, the string is printed without modification.

There are several format characters available for formatting numeric output:

- `#` The hash represents each digit to be printed. These positions are always filled; if a number has less digits than have been specified, the number will be printed right justified with spaces padding the left.
- `.` A decimal point is printed. If `format_string` specifies that a digit precedes the decimal, a digit will always be printed, even if is zero.
- `+` This causes the sign of the number (+/-) to be printed at the beginning or end of the string, depending on whether the + is at the beginning or end of `format_string`.

- `-` When placed at the end of `format_string`, this causes a minus sign to be printed if the number is negative. If the number is positive, this has no effect.
- `**` This causes leading spaces of a number to be filled with asterisks. A double asterisk also represents two more digit positions.
- `$$` The double dollar-sign causes a dollar-sign to be printed to the immediate left of the number; two more digit positions, one of which is for the $, are specified.
- `**$` This results in a combination of ** and $$; leading spaces are asterisks and a $ is printed before the number. Three more digit positions are specified, one of which is taken up by the dollar-sign. If a number is negative, a minus sign immediately precedes the $.
- `,` If specified before a decimal point, a comma is printed every three digits to the left of the decimal. If , is specified at the end of `format_string`, it is printed as part of the number. The comma specifies one additional digit position and has no effect when used together with `^^^^`.
- `^^^^` The four carets specify exponential format. Space is reserved for `E+xx` to be printed. the decimal point may be specified to be anywhere in the number. The significant digits of the number are left justified. Unless a leading/trailing + or a trailing - are specified, one digit position to the left of the decimal point will be used to print the number's sign. Note that double-precision numbers can have five digit exponents, so five carets should be used.
- `_` An underscore before a character in the `format_string` causes the character to be printed as a literal; an underscore will be printed by specifying two consecutive underscores in the `format_string`.

A percent sign is printed, if the number to be printed exceeds the field in the `format_string`. If a rounded number is larger than the field, a percent sign will be printed in front of the number.

The currency symbol that is printed when using the $ formats above. To do this you should change the byte at SYSTAB+66. For example,

```
POKEB SYSTAB+66,ASC("£")
```

will change it to the U.K. pound sign.

• See

PRINT, WRITE, FORMAT*x*$.

• Example

```
PRINT USING "!";"FRED"
PRINT USING "\ \";"JOHN"
PRINT USING "&";"Today is"
PRINT USING "###.#";25.4
PRINT USING "#.#";2.54
PRINT USING "##.##   ";12.34,5.678,1.2
PRINT USING "+#.# ";-1.1,2.2
PRINT USING "#.#- ";-3.3,4.4
PRINT USING "**#.# ";56.78,-91.2,-3
PRINT USING "$$##.#";123.45
PRINT USING "**$##.##";2.54
PRINT USING "####,.##";4567.89
PRINT USING "+####^^^^";-0.4444
PRINT USING "_£##.##";4.99
PRINT USING "#.#";33.25
PRINT USING ".##";.999
```

Results:

```
F
JOH
Today is
 25.4
2.5
12.34   5.68   1.20
-1.1 +2.2
3.3- 4.4
*56.8 -91.2 *-3.0
$123.5
***$2.54
4,567.89
-4444E-04
£ 4.99
%33.3
.99
```


PSET statement

• Syntax

PSET [STEP] (*x_pos*,*y_pos*) [,*colour*]

• Effect

This statement plots a pixel of a given colour in the current window.

• Comments

The *colour* parameter specifies the colour of the pixel to be plotted, and if omitted defaults to the current line colour. The parameters *x_pos* and *y_pos* specify the pixel to be plotted, relative to the top left of the current window. If the optional STEP keyword is specified then the co-ordinates are taken relative to the last PSET or PRESET co-ordinates.

• See

PRESET, POINT, BAR, v_pline GEMVDI routine.

• Example

```
pi=3.1415926
FOR i=0 to 4*pi STEP 0.05
    PSET (i*50,100+100*SIN(i))
NEXT i
```

PUT file I/O statement

• Syntax

PUT [#]*channel_number*[,*record_number*]

• Effect

This statement writes a record from the random-access buffer to the designated random-access file.

• Comments

channel_number is the number specified when the file was opened.

If *record_number* is not specified, the record written will be the next record.

• See

GET, OPEn, CLOSE, *User Manual : Concepts* chapter.

• Example

```
LSET a$=address$(10)
PUT #1,10
LSET a$=address$(11)
PUT #1          'will be record 11 by default
```


PUT graphics statement

• Syntax

PUT (*x*,*y*),*array_name*[(*arrayindex...*)][,*verb*]

• Effect

This statement copies (or *blits*) onto the screen a rectangular image saved with GET.

• Comments

The top left of the rectangle relative to the screen is defined by *x* and *y*. If the array was not filled by a GET then unpredictable and potentially disastrous events may occur.

The optional *verb* parameter allows the mode of the copy to be specified. This can be in the form of various reserved words, or an integer. Allowed verbs are:

PSET	Copies the image directly onto the screen, obliterating any previous contents.
PRESET	Similar to PSET but a negative image results.
AND, OR, XOR	Resulting pixels are a result of the given operation performed on source and destination pixels.

The default verb is XOR. The verb may also be described in terms of an integer expression, the effect of which is described in *Chapter 2 GEM VDI: Raster Functions*.

The height and width that are used are stored when the image is saved with GET.

The GET command acts on the *current* screen; to change the current screen (e.g. for animation) you should update the long word at SYSTAB+50.

Multi-dimensional arrays may be used in this statement, making it easy to switch between different images.

• See

GET, vro_cpyfm GEMVDI call.

• Example

```
DIM scr%(4347-1)    ' -1 as array starts at 0
GET (10,20)-(100,200),scr%
FOR i%=0 to 200 STEP 20
    PUT (i%,i%),scr%,PSET
NEXT i%
```

RANDOMIZE statement

• Syntax

RANDOMIZE [*expression*]

• Effect

This statement provides the random number generator with a new seed.

• Comments

If no *expression* is supplied, RANDOMIZE will prompt the user for a seed. *expression* may be any integer expression. If TIMER is given as *expression*, the TIMER function will provide the seed.

The RND function will produce the same sequence of random numbers unless re-seeded.

Note that the same seed will give exactly the same random number sequence each time.

• See

RND.

• Example

```
Seed%=42
RANDOMIZE Seed%
Rand!=RND
```


READ statement

• Syntax

READ *variable_list*

• Effect

This statement assigns values from DATA statements to variables.

• Comments

READ cannot be used without a DATA statement. The variable type in a READ statement will be converted to the variable type in the DATA statement from which the value is read.

The number of elements in a DATA statement should not exceed the number of variables in the READ statement. If there are more elements in a DATA statement then are READ, the extra elements are ignored.

To re-READ the elements of DATA statements, the RESTORE statement is used.

• See

DATA, INPUTS, INPUT.

• Example

```
DIM Arr&(5)
FOR I%=1 TO 5
    READ Arr&(I%)
NEXT I%
DATA &H42424242,&HFC0DDD,12DD,-45D02
```

REDIM statement

• Syntax

```
REDIM [PRESERVE|APPEND]
      array(subscripts)[,array(subscripts)]...
```

• Effect

This statement changes the size of a dynamic array.

• Comments

subscripts may be integer or long integer expressions. REDIM can even used to change the number of dimensions in an array. Any data that is in an array when it is REDIMmed is lost.

Arrays that are to be REDIMed must be dynamic. That is they must be originally DIMed with an expression (not just a constant) ore REM $DYNAMIC must be in effect when they are originally DIMmed.

REDIM PRESERVE is used to add space to a *one-dimensional* array without destroying the information contained in the array. If the subscript of a REDIM PRESERVE is smaller than the original array, the array will be truncated; this also happens without loss of data in the remaining elements.

REDIM APPEND is equivalent to REDIM PRESERVE for compatibility with HiSoft BASIC version 1. REDIM PRESERVE is to be preferred since this is used by MicroSoft BASIC 7.1 on the PC.

• See

DIM, ERASE, *User Manual : Concepts* chapter.

• Example

```
DIM Fred%(256)
FOR I%=1 TO 256
    Fred%(I%)=I%
NEXT I%
REDIM PRESERVE Fred%(260)
PRINT Fred%(42)
```

Result:

```
 42
```


REM statement

• Syntax

```
REM remarks...
```

• Effect

This statements allows remarks to be added within the source, and also to specify meta-commands.

• Comments

Comments can also begin with ' (i.e. apostrophe). See the *Concepts* chapter in the *User Manual* for details.

If a dollar sign ($) follows the REM it is assumed to be a meta-command (see *Appendix B* and *Chapter 3* of the *User Manual* for further details), otherwise the rest of the line is ignored.

• See

Appendix B.

Example

```
' $OPTION A+
REM The preceding line forces array checks on
```

REPEAT...END REPEATstatement

• Syntax

```
REPEAT name
.
.
[EXIT name]
.
.
END REPEAT name
```

• Effect

The statements within the REPEAT loop are executed until an EXIT statement for the loop is executed.

• Comments

The *name* is a valid variable name that is not currently being used in the program. You can re-use the same name for a number of different REPEAT loops but do not use the name of a sub-program, variable or function.

This loop is the most general looping construct in HiSoft BASIC because each loop is named and you can exit out of an outer loop from within an inner one (see the example below). However when this facility is not required DO...LOOPs are normally clearer, require less typing and are compatible with MicroSoft BASIC as well.

Note that REPEAT is *not* specified in the EXIT statement.

• See

DO...LOOP, WHILE...WEND, FOR...NEXT.

• Example

```
i=0: sum=0
REPEAT one
    i=i+1: j=0
    REPEAT two
        j=j+1
        sum=sum+a(i,j)
        IF sum>10000 THEN
            PRINT "Total too big": EXIT one
        END IF
        IF j=n THEN EXIT two
    END REPEAT two
    IF i=n THEN EXIT one
END REPEAT one
'This example totals the elements in the two-dimensional
'array a() stopping immediately when the sum becomes
'greater than 10000.
```

RESET statement

• Syntax

RESET

• Effect

This statement closes all open disk files.

• Comments

All disk write buffers are written to disk and the files are then closed. Since all files are closed automatically on exit you normally do not need to use this command. It is provided for compatibility with other BASICs.

• Example

```
IF a$="QUIT" THEN RESET : SYSTEM ' the RESET is redundant
```


RESTORE statement

• Syntax

RESTORE [{*line_number*|*label*}]

• Effect

This statements enables a READ statement to access a DATA statement that has been read previously.

• Comments

line_number or *label* specify the DATA statement that is to be READ again. If no *line_number* or *label* is specified, the next READ statement will read the first DATA statement to appear in the program.

• See

READ, DATA, INPUT.

• Example

```
READ John&
PRINT John&
John&=0
PRINT John&
RESTORE J_data
READ John&
PRINT John&
.
.
J_data:
DATA 3448325377,4020987683
```

Result:

```
 3448325377
 0
 3448325377
```

RESUME statement

• Syntax

RESUME {*line_number*|*line_label*}

• Effect

This statement resumes program execution from within an error handling routine at the specified program line.

• Comments

This command is for use from error handling routines set up with ON ERROR GOTO to resume execution of the program at the given position. If the statement is used when not in an error-handler a fatal error will occur.

It is the programmers responsibility that the RESUME is to the same program level as when the error occurred - that is if it was in a sub-program, function or subroutine the RESUME *must* go there for correct program execution. Failure to adhere to this will result in random forms of program crashes.

• See

ON ERROR, ERL, ERROR.

• Example

```
    a$="TEST.DAT"
open_retry:
    ON ERROR GOTO no_open
    OPEN a$ FOR INPUT AS #1
    ON ERROR GOTO 0 'so that errors are reported
    read_data 1
    ......
no_open:
    PRINT "Cannot find file ";a$
    INPUT "Filename:";a$
    RESUME open_retry
```


RETURN statement

• Syntax

RETURN [{*line_number*|*label*}]

• Effect

This statement returns program execution from a subroutine.

• Comments

Program execution is returned to the line after the GOSUB statement that called the subroutine. If *line_number* or *label* are specified, execution continues on the specified line.

Note that this statement does *not* exit out of sub-programs, use EXIT SUB for this.

• See

GOSUB.SUB, END, EXIT.

• Example

```
GOSUB Routine       'Branch to subroutine
.                   'execution continues here
.                   'after the RETURN
Routine:
.
.
RETURN          'return from subroutine
```

RIGHT$ function

• Syntax

RIGHT$(*string_expression*,*n*)

• Effect

This function returns a string starting at the *n*th character from the right.

• Comments

If *n* is 0, a null string is returned. If *n* is larger than *string_expression*, *string_expression* is returned entirely.

• See

LEFT$, MID$, LEN.

• Example

```
d$=DATE$
PRINT "Year:";RIGHT$(d$,4)
```


RMDIR statement

• Syntax

RMDIR *pathname*

• Effect

This statement removes an empty subdirectory.

• Comments

The subdirectory which is to be deleted must not contain any files. *pathname* must conform to the GEMDOS conventions.

• See

KILL, MKDIR, CHDIR.

• Example

```
KILL "\GARBAGE\*.*"  'remove all files
RMDIR "\GARBAGE"     'then the directory itself
```

RND function

• Syntax

RND[(*n*)]

• Effect

This function returns a pseudo-random single-precision number between 0 and 1.

• Comments

If *n* = 0, the last number generated is returned. If *n* < 0, *n* is used to re-seed the sequence of numbers. If *n* > 0 or is omitted, the next number in the sequence is generated.

The algorithm used is based on that of B.A. Wichman and I.D. Hill (NPL Report DITC 6/82). See also the RANDOMIZE statement.

• See

RANDOMIZE.

• Example

```
Number!=RND(-1)  'the number returned will have
                 'used -1 as the seed
```


RSET statement

• Syntax

RSET *string_variable* = *string_expression*

• Effect

This statement moves data into a random-access file buffer. It can also be used to right-justify the value of the string in *string_variable*.

• Comments

RSET is the counterpart of LSET. If *string_expression* uses less bytes than *string_variable*, the string is right-justified with spaces used as padding.

• See

LSET, GET, FIELD.

• Example

```
z$=SPACE$(80)
RSET z$="On the Right of the Screen"
PRINT z$
```

RTRIM$ function

• Syntax

RTRIM$(*string_expression*)

• Effect

This function returns its string parameter with any trailing spaces removed.

• Comments

RTRIM$ trims spaces from the right. This can be used to remove spaces at the end of user input.

• See

LTRIM$, RIGHT$.

• Examples

```
commandline$=RTRIM$(LTRIM$(COMMAND$))
' commandline$ won't have spaces at the front or the end

PRINT RTRIM$("   HiSoft   ");RTRIM$("BASIC")
```

Result:

```
   HiSoftBASIC
```


RUN statement

• Syntax

RUN [{*line_number*|*file_spec*}]

• Effect

This statement restarts the current program or the program specified by *file_spec*.

• Comments

If *line_number* is specified, the program is restarted on the line specified. Alphanumeric labels are not allowed.

file_spec can be any valid string expression, and can be any type of executable program. In some BASICs filenames do not need to be in quotes, but they are needed in HiSoft BASIC. This facility should not be used when compiling to memory.

RUN will close all open files and clear current user memory before executing.

• See

CHAIN, Execute HGT command, pexec GEMDOS call.

• Example

```
RUN "GEN.PRG"    'executes Gen from the current directory
```

SADD function

• Syntax

SADD(*string_expression*)

• Effect

This function returns the address of *string_expression*.

• Comments

Be very careful when using this function as strings can move about in memory without prior warning if a garbage collect should occur. Thus normally SADD present in the statement that is using the address rather than assigned to a temporary variable.

• See

VARPTR.

• Example

```
Astr$=" BASIC"
PRINT Astr$
POKEB SADD(Astr$),ASC("H")
PRINT Astr$
```

Result:

```
 BASIC
HBASIC
```


SCREEN statement

• Syntax

SCREEN *mode*

• Effect

This statement changes the screen mode.

• Comments

This statement will only work with a colour monitor attached. The available modes are:

0	ST low resolution
1	ST medium resolution
2	ST high resolution (only available on TT colour monitors)
4	TT medium resolution
7	TT low resolution'

Naturally the TT resolutions require a TT. An `Illegal function call in module SCREEN` if you try to access a mode that is not available.

A *mode* of 1 selects ST medium resolution, and a *mode* of 0 selects ST low resolution.

Note that this should only be used from TOS- or TTP-type programs - the GEM AES and VDI cannot cope with a screen mode change from within a program. To change screen modes in a way GEM recognises you have to use the *Set Preferences* option from the Desktop.

Having changed resolutions you may need to change the colour palettes, using PALETTE.

• Example

```
IF getrez%=0 THEN
    SCREEN 1          'go into medium res
    PALETTE
    CLS
    WIDTH 80
END IF
```

SELECT...END SELECTstatement

• Syntax

```
SELECT [CASE|ON] variable

      [CASE|=] case_list
        [EXIT SELECT]
.
.
      [CASE|=] case_list
.
.
      [CASE|=] [ELSE|REMAINDER]
.
.
END SELECT
```

• Effect

One series of statements is executed depending on the value of *variable*.

• Comments

variable can be any non-subscripted variable, numeric or string. If you wish to select on a more complicated expression then this should be assigned to a temporary variable first.

The *case_lists* consist of the following items separated by commas:

expression

or

first_expression TO *second_expression*

or

relop expression

or

IS *relop expression*

If the first is used then if the *variable* is equal to the *expression* then the following statements are executed until the next CASE or = statement.

If the second form is used, then if the *variable* is greater or equal to the *first_expression* and less than or equal to the *second_expression* then the following statements are executed.

In the third and fourth forms *relop* may be one of =,<>,>,>=,<=,< or == and the following statements are executed if the *variable* satisfies the condition.

If there is a CASE ELSE, CASE REMAINDER, =REMAINDER or =ELSE clause then if none of the CASEs match then the following statements will be executed. The CASE ELSE clause must be the last before the END SELECT.

The different alternatives are available for ease of converting programs written in other BASICs. The MicroSoft BASIC form is SELECT CASE...CASE...CASE ELSE... END SELECT.

• See

IF...THEN...ELSE.

• Examples

```
INPUT A,B
SELECT CASE A
CASE 1,IS <0
    PRINT "negative or 1"
CASE IS >B
    PRINT "greater than B"
CASE 13 TO 19
    PRINT "in the teens"
CASE ELSE
    PRINT "different"
END SELECT
INPUT a$
SELECT a$
  ="JOHN","FRED": PRINT "John or Fred"
  = <"A",>"Z": PRINT "Names start with a capital letter"
  = "MARY": PRINT "Mary"
  = REMAINDER
     PRINT "unknown name"
END SELECT
```

SGN function

• Syntax

SGN(*numeric_expression*)

• Effect

This statement returns the sign of *numeric_expression*.

• Comments

If *numeric_expression* < 0, -1 is returned.

If *numeric_expression* = 0, 0 is returned.

If *numeric_expression* > 0, 1 is returned.

numeric_expression may be of any numeric type.

• See

ABS.

• Example

```
Var_one% = -42
Var_two% = 0
Var_thr% = 42
PRINT SGN(Var_one%)
PRINT SGN(Var_two%)
PRINT SGN(Var_thr%)
```

Result:

```
-1
0
1
```


SHARED statement

• Syntax

SHARED *variable_list*

• Effect

This statement enables a subprogram to access variables from the main program without them having been passed as parameters.

• Comments

The *variable_list* may contain variable names and array names, which should be terminated with ( ).

• See

DIM, STATIC, LOCAL, COMMON SHARED.

• Example

```
MAIN:
Fred%=127
John%=76
CALL Routine(John%,10)
.
.
SUB Routine (A%,B%)
SHARED Fred%
    Print Fred%,A%,B%
END SUB
```

Result:

```
 127      76   10
```

SIN function

• Syntax

SIN(*numeric_expression*)

• Effect

This function returns the sine of the *numeric_expression* which must be in radians.

• Comments

This function is calculated with single-precision unless the *numeric_expression* is in double precision, thus forcing a double-precision calculation.

• See

COS, TAN, ATN.

• Example

```
DEF cosecant(a)=1/SIN(a)
```


SOUND statement

• Syntax

SOUND *voice,volume* [,*note*][,*octave*][,*duration*]

• Effect

This statement allows control over the 3 sound channels.

• Comments

voice is the sound channel, from 1 to 3.

volume controls the output for that channel, from 0 (off) to 15 (loudest)

note and *octave* control the pitch of the note. The octave ranges from 1 to 8 and the note from 1 to 12.

duration is the time the note will continue before the beginning of the next sound, in 50ths of a second.

The last sound statement for each channel should turn off the sound, by specifying all other parameters to be zero.

Note that pressing a key will normally kill any sound being made, unless the keyclick feature is disabled with the *Control Panel* or XBIOS call.

C	C#	D	D#	E	F	F#	G	A	A#	B
1	2	3	4	5	6	7	8	10	11	12

Note Table

• Example

```
PRINT "Close encounters..."
SOUND 1,15,10,3,20
SOUND 1,15,12,3,20
SOUND 1,15,8,3,20
SOUND 1,15,8,2,24
SOUND 1,15,3,3,40
SOUND 1,0
```

SPACE$ function

• Syntax

SPACE$(*n*)

• Effect

This function returns a string of spaces (ASCII 32), the length of which is specified by *n*.

• Comments

n must be positive, and within the range of long integers. If merely want to print some spaces it is more efficient to use the SPC function.

• See

STRING$.

• Example

```
DIM names$(100)
FOR i=0 TO 100
    name$(i)=SPACE$(30)
NEXT i
```


SPC function

• Syntax

SPC(*n*)

• Effect

This function causes *n* spaces to be skipped in a PRINT statement.

• Comments

In contrast to SPACE$, SPC may only be used with PRINT and LPRINT. *n* must be positive and within the long integer range. It is not necessary to specify a semi-colon after a SPC, the function will not produce any other characters except the *n* spaces.

In general it is best to use SPACE$ in case you wish to convert the PRINT statement into another statement at a later date.

• See

PRINT, SPACE$, STRING$.

• Example

```
LOCATE 10,1
INPUT "Name:",a$
LOCATE 10,1
PRINT SPC(5+LEN(a$))
LOCATE 10,1
INPUT "Address:",b$
```

SPEEKB, SPEEKL, SPEEKW functions

• Syntax

SPEEKB(*address*)
SPEEKL(*even_address*)
SPEEKW(*even_address*)

• Effect

These functions return the contents of the memory specified using the processor's supervisor mode.

• Comments

SPEEKB returns one byte, SPEEKW returns a word (16-bit) and SPEEKL returns a long (32-bit). On the 68000, when using SPEEKL or SPEEKW, the address specified must be even, otherwise an address error (3 bombs) will occur.

These functions are able to access the hardware registers and low system memory, and thus care is required in their use.

These functions are slower than the corresponding user mode functions PEEKB, PEEKW and PEEKL because of the overhead of entering and leaving supervisor mode.

These functions are supplied a direct interface to the processor instructions. For this reason, no checks are made as to the even-ness of the addresses for SPEEKL and SPEEKW..

SPEEKB and SPEEKW return integers; SPEEKL returns a long integer.

• See

PEEKB, PEEKW, PEEK, SPOKEB, SPOKEW, SPOKEL.

• Example

```
intial200&=SPOKEL(&h4BA)
' initial200& will be current value of the 200Hz timer
```


SPOKEB, SPOKEL, SPOKEW statements

• Syntax

SPOKEB *address, byte_value*
SPOKEL *even_address, long_value*
SPOKEW *even_address, word_value*

• Effect

These statements write data directly into memory in supervisor mode..

• Comments

These statements are slower than POKEB, POKEW and POKEL but they may be used to access supervisor memory and the hardware registers directly.

This is not something that we encourage since it is prone to error, may cause unexpected side effects and may not work as expected on future hardware. In general it is much better to use the operating system calls.

SPOKEL or SPOKEW to an odd address will result in an address error (3 bombs).

• See

PEEKB, PEEKW, PEEK, SPOKEB, SPOKEW, SPOKEL.

• Example

```
conterm=SPEEKB(&h484)

' clear bit 0 ie disable key click
SPOKEB &h484,conterm AND &hFE
```

SQR function

• Syntax

SQR(*numeric_expression*)

• Effect

this function returns the square root of the *numeric_expression*.

• Comments

The *numeric_expression* must be greater than or equal to 0. SQR is normally calculated using single precision maths; if the *numeric_expression* is double-precision, the value returned will be calculated with double-precision.

• Example

```
PRINT SQR(42)
PRINT SQR(42#)
```

Result:

```
6.480741
6.48074069840786
```


STATIC statement

• Syntax

STATIC *variable_list*

• Effect

This statement declares variables as local to function definitions and sub-programs and preserves their values when the function or sub-program is left and re-entered.

• Comments

This statement can be used only within function definitions and sub-programs.

Variables in DEF FN function definitions usually are global. STATIC makes these variables local to the specific function.

We recommend that you use the STATIC statement even when this is the default as it means that you can use the Variable Checks (V) option.

• See

DIM, LOCAL, SHARED, COMMON SHARED.

• Example

```
test=10
PRINT FNeasy,test
DEF FNeasy
STATIC test          'without this the global
test=5             'test would be changed here
FNeasy=1/test
END SUB
```

STICK function

• Syntax

STICK(*n*)

• Effect

This function returns the x and y positions of the two joysticks.

• Comments

n can be:

0	This returns the x position of joystick 0.
1	This returns the y position of joystick 0.
2	This returns the x position of joystick 1.
3	This returns the y position of joystick 1.
4	This returns the x position of STE joystick 1.
5	This returns the y position of STE joystick 1.
6	This returns the x position of STE joystick 2.
7	This returns the y position of STE joystick 2.
8	This returns the x position of STE joystick 3.
9	This returns the y position of STE joystick 3.
10	This returns the x position of STE joystick 4.
11	This returns the y position of STE joystick 4

Note: these functions only work after a `STRIG ON` command has been executed for the standard joysticks.

For the x positions the function returns:

-1: Right 0: Centre 1: Left

For the y positions the function returns:

-1: Down 0: Centre 1: Up

When the x position is requested the y position is also stored at the same time, so the program obtains simultaneous results.

Note that with a mouse connected to port 0 the results from this function are not particularly meaningful or useful.

The STE versions of these commands require that the STE hardware is present.

• See

STRIG, MOUSE.

• Example

```
PSET (200,100)
STRIG ON
DO
    XA% = STICK(2)  'the x position for joystick
                    '1 is returned and the y
                    'position stored
    YA% = STICK(3)
    PSET STEP (XA%,-YA%)    'plot relatively
LOOP UNTIL STRIG(3)         'until Fire button pressed
STRIG OFF
```

STOP statement

• Syntax

STOP [*process_returncode*]

• Effect

This statement causes the program to end; all files are closed and control is returned to the operating system.

• Comments

If no parameter is specified then the message `Program terminated` will appear at the bottom of the screen and it will pause until a key is pressed. To disable this specify a parameter of -1 or use the SYSTEM command.

If a parameter other than -1 is specified this is used as a GEMDOS process return code, useful for TOS programs that are to be run from CLIs, for example. By default the return code is 0 (no error), or the error code+200 if a run-time error occurs.

To return a negative return code use the SYSTEM statement.

• See

SYSTEM, END.

• Example

```
IF FEXISTS(COMMAND$) THEN
    process COMMAND$
    STOP -1      'will return immediately
ELSE
    PRINT "Cannot find ";COMMAND$
    STOP         'will wait for key
END IF
```


STR$ function

• Syntax

STR$(*numeric_expression*)

• Effect

This function returns the string representation of the value of *numeric_expression*.

• Comments

STR$ is the counterpart to VAL.

If *numeric_expression* ≥ 0, the string returned contains a leading space, else it will start with a minus sign. *numeric_expression* may be of any numeric type.

• See

VAL, FORMATx$.

• Example

```
A%=4
B%=6
WRITE STR$(A%*B%)
```

Result:

```
" 24"
```

STRIG function

• Syntax

STRIG(*n*)

• Effect

This function returns the status of the specified joystick fire button.

• Comments

n may be:

0	This returns -1 if the button of joystick 0 was pressed since the last STRIG(0); 0 is returned if this is not the case.
1	-1 is returned if the button of joystick 0 is pressed, 0 if not.
2	This returns -1 if the button of joystick 1 was pressed since the last STRIG(2); 0 is returned if this is not the case.
3	-1 is returned if button of joystick 1 is currently pressed, 0 if not.
4	-1 is returned if button of STE joystick 1 is pressed, 0 if not.
5	-1 is returned if button of STE joystick 2 is pressed, 0 if not.
6	-1 is returned if button of STE joystick 3 is pressed, 0 if not.
7	-1 is returned if button of STE joystick 4 is pressed, 0 if not.

This function will only work after a STRIG ON statement has been executed for the standard joysticks.

The STE versions of these commands require that the STE hardware is present.

Note that the left mouse button is equivalent to joystick 0's fire button and the right button to joystick 1's.

• See

STRIG statement, STICK.

• Example

```
IF STRIG(1) = -1 THEN
    PRINT "Button A is being pressed"
ELSEIF STRIG(3) = -1 THEN
    PRINT "Button B is being pressed"
END IF
```


STRIG statement

• Syntax

```
STRIG ON
STRIG OFF
```

• Effect

This function controls use of the joystick commands.

• Comments

In order to read the joystick ports of the ST it is necessary to turn off mouse movement. The command STRIG ON does this, so that the STICK and STRIG functions will work. The command STRIG OFF will turn mouse movement back on.

Joystick functions will not work before a STRIG ON or after a STRIG OFF.

• See

STICK, MOUSE.

• Example

```
INPUT "Mouse or Joystick";choice$
SELECT CASE choice$
CASE "M"
    mouse_flag=1
CASE "J"
    mouse_flag=0
    MOUSE -1
    STRIG ON
END SELECT
```

STRING$ function

• Syntax

STRING$(*m*,*n*)

STRING$(*m*,*string_expression*)

• Effect

This function returns a string composed of ASCII *n*, which is of *m* length.

• Comments

If *string_expression* is specified instead of *n*, the first character of *string_expression* is used.

• See

SPACES.

• Example

```
PRINT STRING$(40,127)
```

Result:

ΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔΔ

SUB...END SUB statement

• Syntax

```
SUB global_name[(parameter_list)][STATIC]
.
.
[EXIT SUB]
.
.
END SUB
```

• Effect

This statement is used to define a sub-program.

• Comments

global_name	must be a name which is unique throughout the entire program. It is the name which refers to the sub-program.
parameter_list	is the list of parameters that are passed to a sub-program. These may be variable names, array names terminated with (), or literal values. If preceded by the keyword **VAL** then the parameter is always passed by value; this makes execution of the sub-program quicker.
STATIC	is the optional attribute which signifies that the sub-program is not recursive, i.e. it does not call itself. By default, sub-programs have the capability to be recursive. At the time of writing, the compiler ignores this if present.

EXIT SUB causes program execution to return to the part of the program which called the sub-program. It is used to exit the sub-program before the END SUB.

Variables within a sub-program may be declared LOCAL, SHARED or STAIIC. Please refer to these statements for detailed explanations and also the *User Manual : Concepts* chapter for more details of sub-programs.

User defined functions may not be a part of a sub-program definition.

• See

FUNCTION, STATIC, SHARED, LOCAL, EXIT, END, CALL.

• Example

```
CALL Fred(1,2)
.
.
SUB Fred(One%,Two%)
STATIC RecurDepth
    INCR RecurDepth
    IF RecurDepth > 4 THEN EXIT SUB
    PRINT One% Two%
    CALL Fred(One%*2,Two%*2)
END SUB
```

Result:

```
 1  2
 2  4
 4  8
 8  16
```


SWAP statement

• Syntax

SWAP *1st_variable*, *2nd_variable*

• Effect

This statement causes the values of the two variables to be exchanged.

• Comments

The two variables must be of exactly the same type, and can be numeric or string.

• See

LSET, RSET.

• Example

```
A% = 1
B% = 2
SWAP A%,B%
PRINT A%;B%
```

Result:

```
 2  1
```

SYSTAB function

• Syntax

SYSTAB

• Effect

Returns the address of an internal system table.

• Comments

This is included mainly for ST BASIC compatibility, though can be useful for other reasons. The table consists of 13 ST BASIC compatible integers and various additional integers. The table should be accessed using

PEEKW(SYSTAB+*offset*)

but normal ST BASIC-style PEEKs will also work, though more slowly. The table contents are as follows:

0	Number of graphics planes
2	*editor ghostline style = 2*
4	*EDIT AES handle = 0*
6	*LIST AES handle = 0*
8	OUTPUT AES handle
10	*COMMAND AES handle = 0*
12	*EDIT open flag = 0*
14	*LIST open flag = 0*
16	OUTPUT open flag = 1
18	*COMMAND open flag = 0*
20	*graphics buffer, long integer = 0*
24	*GEMFLAG = 0*
26	x position of usable area
28	y position of usable area
30	x position of right hand of usable area
32	y position of bottom of usable area
34	copy of workstation VDI handle
36	character pixel width
38	character pixel height
40-46	workstation size in the form x,y,w,h
48	version number in hex, e.g. &h0123=1.23
50	assumed screen address for PUT and GET - you can POKEL this with an alternate screen address
54	long integer pointer to the current base page
58-64	x,y,w,h required to open a full sized window for use with WINDOW OPEN
66	byte the currency symbol for $ in PRINT USING.
67	If non-zero then sequential write files have a Ctrl-Z appended to them when they are closed.
68	The size of the LINE INPUT# buffer as a long word.
72	Top margin of GEM windows when using the PRINT statement (default 1) as a word
74	bottom margin of GEM windows when using the PRINT statement (default 1) as a word

Those shown in italics are never changed, but have fixed values for compatibility with ST BASIC.

The five integers starting at offset 26 return information about the current output window and VDI handle - this is a HiSoft BASIC extension useful for converting between screen co-ordinates and window co-ordinates.

TOS programs only have access to SYSTAB+67 and SYSTAB+68 - the other entries are not initialised.

• See

PEEKL, PEEKW, PEEKB, WINDOW OPEN, LINE INPUT#, PRINT USING.

• Example

```
DO
    IF MOUSE(2)=1 THEN
        x%=MOUSE(0)-PEEKW(SYSTAB+26)
        y%=MOUSE(1)-PEEKW(SYSTAB+28)
        PSET (x%,y%)
    END IF
LOOP UNTIL MOUSE(2) AND 2   'until right button
```

SYSTEM statement

• Syntax

SYSTEM [*return_code*]

• Effect

This statement causes program execution to end, closes all files, and returns to the operating system.

• Comments

This statement does not issue a `Program terminated - press any key` message unlike STOP.

The optional parameter is a GEMDOS return code for passing back to the shell that has called the program.

SYSTEM without a parameter is equivalent to STOP -1.

• See

END, STOP.

• Example

```
IF UCASE$(a$)="QUIT" THEN SYSTEM
SYSTEM -33  'GEMDOS File not found error
```


TAB function

• Syntax

TAB(*n*)

• Effect

This function causes the print position to move to the *n*th column.

• Comments

If the current print position is already beyond *n*, then the print position will move to the *n*th column on the next line. If *n* is greater than the output width, the print position is moved to *n* MOD WIDTH. If *n* is less than one, the print position will become 1. TAB may only be used in PRINT and LPRINT statements.

• See

PRINT, LPRINT, SPC.

• Example

```
'80 column screen
PRINT TAB(-10) "minus ten"
PRINT TAB(175) "one-hundred-and-seventy-five"
PRINT TAB(10) "ten"
```

Result:

```
minus ten
                    one-hundred-and-seventy-five
          ten
```

TAN function

• Syntax

TAN(*numeric_expression*)

• Effect

This function returns the tangent of *numeric_expression* which must be in radians.

• Comments

The tangent is normally calculated with single-precision. If *numeric_expression* is double-precision, the value returned will be calculated with double-precision.

• See

ATN, SIN, COS.

• Example

```
PRINT TAN(0.5)
```


TIME$ function

• Syntax

TIME$

• Effect

This function returns the current system time.

• Comments

A string of the following format is returned:

hh:mm:ss	*hh* is the hours in 24hr format (00-23) *mm* is the minutes (00-59) *ss* is the seconds (00-59)

Note that the ST's internal clock only gives the time to the nearest 2-second increment.

• See

DATE$, Tgettime GEMDOS call.

• Example

```
PRINT TIME$
```

Result:

```
20:43:56            'it's 8:43 pm
```

TIME$ statement

• Syntax

```
TIME$ = string_expression
```

• Effect

The system time is set.

• Comments

string_expression can have one of the following formats:

hh	sets only the hours
hh:mm	sets the hours and minutes
hh:mm:ss	sets the hours, minutes and seconds

A 24hr clock is used, so 11pm is 23:00:00.

To read the time, use the TIME$ function.

• See

DATE$, Tsettime GEMDOS call.

• Example

```
TIME$ = "19:30:00"  '7:30pm
```


TIMER function

• Syntax

```
TIMER
```

• Effect

This function returns an internal timer count in seconds as a single-precision floating point number.

• Comments

This function can be used to provide a seed for RANDOMIZE. It returns using 200ths of a second precision. It can be used for timing programs, for example.

There is no actual meaning to this number - it is merely an increasing number.

• See

TIME$.

• Example

```
t!=TIMER
call Main
t!=TIMER-t!
PRINT "It took";t!;"seconds"
```

TRON,TROFF statements

• Syntax

TRON

TROFF

• Effect

These statements allow tracing of a program by line number as it runs.

• Comments

After a TRON statement has been executed all program line numbers are printed on the screen as execution occurs. It can be switched off with TROFF.

Line numbers are printed within square brackets.

The use of TRON in a program considerably slows down program execution, even after a TROFF statement. For this reason all TRONs should be removed from a program once it has been debugged for maximum performance.

TRON and TROFF may not be used in desk accessories.

• Example

```
1000 TRON
1010 PRINT "In problem area"
1020 INPUT a
1030 PRINT "Input";a,"Result";fnTest(a)
1040 TROFF
```


UBOUND function

• Syntax

UBOUND(*array_name*[,*dimension*])

• Effect

This function returns the largest available subscript of the array (and optionally the dimension) specified.

• Comments

dimension is specifies the dimension of the array for which the upper bound is to be returned. If *dimension* is not specified the default is 1.

• See

LBOUND, DIM.

• Example

```
DIM An_array%(10,20,30)
PRINT UBOUND(An_array%,2)
```

Result:

20

UCASE$ function

• Syntax

UCASE$(*string_expression*)

• Effect

This function returns a string with every alphabetic character in upper case.

• Comments

Any characters in the range 'a' to 'z' inclusive are converted to 'A' to 'Z' as required. All other characters including accented letters are left alone.

• See

LCASE$.

• Example

```
' the array must be passed by reference
' 1 defines the number of dimensions
FUNCTION find(BYVAL a$,array$(1))
STATIC i,f
f=0
FOR i=LBOUND(array$) TO UBOUND(array$)
IF UCASE$(f$)=array$(i) THEN f=i: EXIT FOR
NEXT i
find=f
END FUNCTION
```


VAL function

• Syntax

VAL(*string_expression*)

• Effect

This function returns the numeric value of *string_expression*.

• Camments

This function parses *string_expression* looking for a sequence of characters that can be interpreted as a number. VAL will stop reading the string upon finding the first character that cannot be recognized as a number. Leading blanks, tabs, and CR-LFs are ignored. VAL returns a double-precision number but it can, of course be assigned to a variable of less precision.

• See

STR$.

• Example

```
addr$=" 26 Church Lane"
num%=VAL(addr$) 'will be 26
```

VARPTR function

• Syntax

VARPTR(*variable_name*)

or

VARPTR(*#channel*)

• Effect

This function returns the address in memory of the variable *variable_name*, or of the input/output buffer of the *channel*.

• Comments

The address returned is a long integer. VARPTR may be used on any numeric variable type; use SADD to find the address of strings. To find the address of an array, specify the first element in the array.

Be careful to use VARPTR just before the returned address is to be used. Local numeric variables and all strings and arrays may not remain in the same place for the duration of the program.

VARPTR with a channel number as a parameter returns the address of the input/ output buffer for an already OPENed channel. If the channel is not opened then 0 is returned. You can also use this to find whether a HiSoft BASIC window is open; use a channel number of 257+i for window i. This will return non-zero if the window is open; zero if it is not.

VARPTR will always return an even address.

The keyword VARPTR is also used in function definitions to denote variable parameters (as opposed to value parameters).

• See

SADD, VARPTRS.

• Example

```
Number% = 7
Addr& = VARPTR(Number%)
PRINT HEX$(Addr&)
```

Result:

6A558

VARPTRS function

• Syntax

VARPTRS(*subname*)

• Effect

This function returns the address in memory of the sub-program *subname*.

• Comments

The address returned is a long integer. This can be used in conjunction with CALLS. The sub-program should have no parameters.

Note: this is for advanced programmers only.

• Example

```
IF from_disk THEN
    read_routine&=VARPTRS(disk_read)
ELSE
    read_routine&=VARPTRS(ram_read)
END IF
```

WAVE statement

• Syntax

WAVE *enable*[,*envelope*[,*shape*[,*period*[,*delay*]]]]

• Effect

Controls the waveforms used by the SOUND statement.

• Comments

enable is the mixer register of the sound generator and is a bitwise value as follows:

bit	action
0	0=enable tone on channel A, 1=disable tone on channel A
1	0=enable tone on channel B, 1=disable tone on channel B
2	0=enable tone on channel C, 1=disable tone on channel C
3	0=enable noise on channel A, 1=disable noise on channel A
4	0=enable noise on channel B, 1=disable noise on channel B
5	0=enable noise on channel C, 1=disable noise on channel C

envelope is used to enable the envelope generator for the different channels. This is a bit organised value as follows:

bit	action
0	0=disable envelope for channel A, 1=enable envelope for channel A
1	0=disable envelope for channel B, 1=enable envelope for channel B
2	0=disable envelope for channel C, 1=enable envelope for channel C

shape is the envelope shape as follows

shape value	wave form
0 - 3	
4 - 7	
8	
9	
10	
11	
12	
13	
14	
15	

period sets the period of the envelope (from 1 to 65535) and *delay* determines the time in 50ths of a second before the command finishes.

• See

SOUND.

• Example

```
SOUND 1,15,10,3,20
WAVE 1,1,12,10,20
SOUND 1,15,10,3,20
SOUND 1,0
```

WHILE...WEND statement

• Syntax

```
WHILE condition
.
.
[statements]
.
.
WEND
```

• Effect

A series of statements are executed in a loop until *condition* becomes false.

• Comments

While *condition* is true, the statements between WHILE and WEND are executed.

WHILE...WENDs may be nested; a WEND will match the last WHILE.

Be careful not to begin a WHILE...WEND loop from within it (e.g. due to a GOTO).

DO...LOOP and REPEAT loops are more general versions of the while loop.

• See

DO..LOOP, REPEAT.

• Example

```
A%=0
WHILE A%<10
    INCR A%
    PRINT A%;
WEND
```

Result:

```
 1  2  3  4  5  6  7  8  9  10
```


WIDTH statement

• Syntax

```
WIDTH [#channel_number,] width [,tab_setting]
WIDTH LPRINT width [,tab_setting]
```

• Effect

These statements assign a line width to the specified file, screen or printer.

• Comments

The following parameters are valid for this statement:

width	This sets the width for output to the screen.
#channel_number,width	This sets the width of output to *channel_number* to the specified width. Note that the # is compulsory.
tab_setting	sets the length of a tab; default is 14.

Specifying LPRINT controls the *width* and *tab_length* of any output to the printer.

If a *width* of 255 is specified then the width is set to 'infinite'; that is BASIC never inserts CR-LFs during output.

• Example

```
WIDTH 80                'sets an 80 column screen
WIDTH LPRINT 40,8       'set printer output to 40
                        'columns and tab length of 8
```

WINDOW statements

• Syntax

```
WINDOW OPEN id,title_string,xpos,ypos,width,height,type
WINDOW CLOSE [id]
WINDOW OUTPUT [id]
WINDOW FULLW [id]
WINDOW NAME id[,title_string][,status_string]
WINDOW LOCATE id,xpos,ypos,width,height
WINDOW ON
WINDOW OFF
WINDOW CONTRL id,control,value
WINDOW READ id,control,result
WINDOW GET id,rectangle,xpos,ypos,width,height
WINDOW SYSTEM
WINDOW STOP
```

• Effect

Control multi-window screen output.

• Comments

There are many versions of the WINDOW command to help use and control multi-window output via GEM.

Most commands require a window *id*, which is a number used to identify each window, ranging from 0 to 7 inclusive. By default when a GEM program starts it opens window *id* 2 to be the whole screen size except for the menu bar. All PRINT, INPUT and graphics commands use this window, known as the *current window*, until directed otherwise.

Note that a window id is a method used by BASIC to refer to windows - ids should not be passed to the AES without conversion to proper AES handles, using WINDOW READ.

Now the individual window commands are discussed in detail.

WINDOW OPEN id,title_string,xpos,ypos,width,height,type

This opens a new window, after closing any existing window with the given *id*. The title of the window is specified by the *title_string*, and *xpos*, *ypos*, *width* and *height* specify its position relative to the top left of the screen and its size.

The *type* parameter determines what sort of window is produced, and should be made up by adding together the following numbers for the attributes required:

1	(&h1)	Title bar
2	(&h2)	Close box
4	(&h4)	Full box
8	(&h8)	Move box, allowing it to be dragged around the screen
16	(&h10)	Information line, empty initially (see WINDOW NAME)
32	(&h20)	Size box, allowing it to be re-sized
64	(&h40)	Up arrow
128	(&h80)	Down arrow
256	(&h100)	Vertical slider
512	(&h200)	Left arrow
1024	(&h400)	Right arrow
2048	(&h800)	Horizontal slider

The newly opened window will be at the front and made the current window.

WINDOW CLOSE [id]

This closes the given window. If this was the current window then any attempt to PRINT or otherwise use it will cause an error. If *id* is omitted it defaults to 2.

WINDOW OUTPUT [id]

This makes the given window the current one. All PRINT, INPUT and graphics commands will go to it. If *id* is omitted it defaults to 2.

WINDOW FULLW [id]

This makes the given window bigger than the complete size of the screen such that the usable area is the whole screen. The window covers the menu bar rendering it unusable. This can be useful for full screen graphics. If *id* is omitted it defaults to 2.

WINDOW NAME id , [title_string] [,status_string]

This lets you change the title and/or the status line on the given window. If either string is omitted then that attribute will be left alone.

WINDOW LOCATE id,xpos,ypos,width,height

This lets you move and re-size windows around the screen.

WINDOW ON

This command lets the run-time system take control of all VDI clipping and messages, and is the default state.

WINDOW OFF

This command stops the run-time system from doing clipping and message absorption, and is intended for more advanced programmers who wish to use the AES and VDI routines for screen output and message handling.

WINDOW CONTRL id,control,volue

This command lets you set the values of the different window controls, such as scroll bars, and change which window is at the front. The `control` values should be one of the following:

	Control	*Value*
0	horizontal slider position	1=leftmost, 1000=rightmost
1	vertical slider position	1=top, 1000=bottom
2	horizontal slider size	1 to 1000
3	vertical slider size	1 to 1000
4	set front window	ignored - uses id

WINDOW READ id,control,result

This command lets you read the values of the different window controls, such as scroll bars. The `result` argument must be an integer variable, into which the result will be placed.

	Control	*Result*
0	horizontal slider position	1=leftmost, 1000=rightmost
1	vertical slider position	1=top, 1000=bottom
2	horizontal slider size	1 to 1000
3	vertical slider size	1 to 1000
4	read front window	window id or -1 if not a BASIC window, -2 if no windows, ignores *id* parameter
5	read AES handle	AES handle
6	convert from AES handle	window id, or -1 if not a BASIC window

WINDOW GET id,rectongle,xpos,ypos,width,height

This command lets you read the co-ordinates of the various rectangle which make up a GEM window, intended for advanced programmers. The variables `xpos`,`ypos`, `width` and `height` must all be integer variables, into which the results are placed.

	Rectangle
0	usable area of window
1	total size of window including borders
2	co-ordinates of window at maximum size
3	first rectangle in window list
4	next rectangle in window list

WINDOW SYSTEM

This command causes the GEMVDI workstation to be opened and the window system to be initialised. The appropriate items in the SYSTAB table are also initialised. `WINDOW SYSTEM` may only be used in desk accessories.

WINDOW STOP

This command causes the GEMVDI workstation to be closed; any open windows should be closed before calling this This may only be used in desk accessories.

• See

PRINT, WRITE, PSET, GEMAES window functions, GEMVDI library.

• Example

```
' Get the position, width and height of the free
' window that HiSoft BASIC gives you

WINDOW GET 2,1,wx,wy,ww,wh

' Re-locate and name the free window you get
' when running a HiSoft BASIC GEM program.
' This always has id number 2.

WINDOW LOCATE 2,0,25,320,200,wh\2
WINDOW NAME 2," Top Window "
COLOR 1,1,1,5,2
PELLIPSE 320,WHEIGHT\2,200,WHEIGHT\4
WINDOW OPEN 1," Another Window ", _
 0,25+wh\2,640,wh\2,1+512+1024+2048
PRINT "Hello"
WINOOW CONTRL 1,0,500
WINOOW CONTRL 1,2,100
```

WRITE statement

• Syntax

WRITE [*expression_list*]

• Effect

This statement prints the data specified in *expression_list* to the screen.

• Comments

This statement is similar to PRINT. If *expression_list* is omitted, a CR-LF will be printed to the screen. All expressions must be separated by commas. These commas are printed as well. Semi-colon may be used instead of comma; this also outputs a comma.

Strings printed using WRITE are quoted, and numbers printed using WRITE do not have leading or trailing spaces, unlike PRINT.

A CR-LF is always output at the end of a WRITE statement.

• See

PRINT, WRITE#, INPUT.

• Example

```
A% = 24
B$ = "STRING!"
PRINT A%,B$
WRITE A%,B$
```

Result:

```
 24       STRING!
24,"STRING!"
```


WRITE# statement

• Syntax

WRITE #*channel_number*, *expression_list*

• Effect

This statement writes the data specified by *expression_list* to a sequential file.

• Comments

WRITE# differs from PRINT# in the same ways as WRITE differs from PRINT. WRITE# has the advantage that data can be read back from the file with the equivalent INPUT# statement; this is not normally the case for PRINT.

For further details, please consult the PRINT# and WRITE entries.

• See

PRINT#, WRITE, INPUT#.

• Example

```
OPEN fS FOR OUTPUT AS #1
FOR i=1 TO 10
    WRITE #1,i,CHR$(i+"a"%)
NEXT i
CLOSE #1
OPEN fS FOR INPUT AS #1
WHILE NOT EOF(1)
    INPUT #1,a,a$
    PRINT a,a$
WEND
CLOSE #1
```

Chapter 2
Library Reference

Introduction

HiSoft BASIC is supplied with several *libraries*, a collection of functions and/or sub-programs callable, with ease, from BASIC. The file HBASIC.LIB contains, apart from the normal run-times, five additional libraries:

BIOS	Basic Input/Output (I/O)
XBIOS	Extended Basic I/O
GEMDOS	The Operating System
GEMVDI	Virtual Device Interface
GEMAES	Application Environment Services

If you want to use any particular library you have to specify its name via the LIBRARY statement, then you can use all of its features.

For example, there is an XBIOS function to find out where the screen is in memory, so if you wanted to save a copy of it to disk you could use this simple program:

```
LIBRARY "xbios"

CIRCLE 100,100,100
PRINT "Hello"
BSAVE "SCREEN.DMP",logbase&,32000
```

The first line says *I want to use the XBIOS*, while on the last line you can see logbase&, which is a function defined not in your program, like normal functions, but in the library itself.

When using the supplied libraries you will often need to pass an *address* as a parameter. This can be done using the VARPTR function, or SADD in the case of strings, where required.

There are a few functions and subroutines which are absolutely straightforward to use, such as logbase& mentioned previously. However a good number of the BIOS, XBIOS and GEMDOS calls can cause complete havoc to the system. If you don't fully understand a call before using it, the machine is quite likely to crash, so always save any vital data on a permanent disk before trying a new one out.

Space does not permit a complete description of every one of the system calls in this document, so you are referred to the books in the *Bibliography* in the *User Manual* for further details.

Important Note

Please note that we have listed all the sub-programs and functions in a form that shows their definition. This means that each heading begins with the word SUB or FUNCTION depending on the type of the library entry - obviously you do not use the word SUB or FUNCTION when you call the routine.

Also, the routine's parameters are shown as they would be defined; if a parameter is preceded by the word BYVAL then it is a value parameter, otherwise it is a variable parameter, which is the default for SUBs and FUNCTIONs. Again, you must not type the word BYVAL when you call the routine in question - it is there just to show you what type of parameter the routine accepts.

The Libraries

The GEMDOS Library

SUB pterm0

This statement makes the old GEMDOS call to terminate a program. It should never be used to terminate a BASIC program.

FUNCTION cconin&

This function returns one character from the keyboard. The high-word contains the scancode of the key pressed, the low-word contains the ASCII code.

SUB cconout(BYVAL char%)

A statement that prints the ASCII character char% to the console.

FUNCTION cauxin%

This function returns a character from the serial port AUX: or a TOS error number.

FUNCTION cauxout%(BYVAL chr%)

Writes a character to AUX: and returns a (negative) TOS error number if it fails. A function.

FUNCTION cprnout%(BYVAL chr%)

This function writes a character to PRN: and returns a (negative) TOS error number if it fails.

FUNCTION crawio%(BYVAL chr%)

A function that returns a character from the standard input if chr%=&HFF; otherwise a character is written to the standard output.

FUNCTION crawcin%

This function returns a raw character from the standard input without echo.

FUNCTION cnecin%

Returns a raw character from the standard input without echo; Ctrl-C, Ctrl-S and Ctrl-Q are interpreted and have effect. A function.

SUB cconws(BYVAL string$)

This statement causes string$ to be written to the standard output.

SUB cconrs (BYVAL buffer%())

A statement that causes a line to be read from the standard input into buffer%(). The array need not be longer than 256 bytes (i.e. 128 elements), as the maximum string length returned from GEMDOS is 255 bytes; the maximum number of characters that can be typed in is determined by the size of the array. Ctrl-C, Ctrl-S and Ctrl-Q are interpreted and have effect.

FUNCTION cconis%

This function returns -1 if a character is available from the standard input, 0 is returned otherwise.

FUNCTION dsetdrv%(BYVAL driveno%)

Sets the GEMDOS current drive; 0 for A:, 1 for B: etc. The system drive bitmap is returned (bit 0 set means drive A: is available etc.). A function.

FUNCTION cconos%

Function returns -1 if the console is ready to receive a character, 0 if not.

FUNCTION cprnos%

Returns -1 if the printer port is ready to receive a character, 0 if it isn't.

FUNCTION cauxis%

A function that returns -1 if a byte is available from the serial port, 0 if not.

FUNCTION cauxos%

Returns -1 if the serial port is ready to receive a character, 0 if it isn't.

FUNCTION maddalt&(BYVAL start&, BYVAL size&)

This is used to inform the operating system of the presence of alternative memory in the system - only for use by VME RAM on machines that support this and is available on TOS 2 and above only. 0 is returned if the function succeeds; otherwise an error code is given.

FUNCTION dgetdrv%

This function returns the GEMDOS current drive, 0 for A:, 1 for B: etc.

SUB fsetdta(BYVAL buffer&)

A statement that sets the disk transfer address to the 44-byte buffer pointed to by `buffer&`. If you use `fsetdta`, be sure to restore the old DTA (which is returned by `fgetdta`). If you do not do this, the BASIC file system will become confused.

FUNCTION super&(BYVAL address&)

This function causes the processor to go into supervisor mode or to come out of it. Upon entering supervisor mode, `address&` is the value of the new supervisor stack pointer or 0 if the current user stack pointer should be used. The returned long integer is the old supervisor stack pointer which *must* be passed back to `super&` when leaving supervisor mode. When using `super&` to enter supervisor mode, make sure to leave supervisor mode properly as well. Remain in supervisor mode only as long as necessary.

FUNCTION tgetdate%

A function that returns the system date in the format:

Bits	
0-4	day 1-31
5-8	month 1-12
9-15	year 0-119 since 1980

SUB tsetdate(BYVAL date%)

This statement sets the date using the format shown above.

FUNCTION tgettime%

A function that returns the system time in the format:

Bits	
0-4	second 0-59, divided by two
5-10	minute 0-59
11-15	hour 0-23

SUB tsettime(BYVAL time%)

This statement sets the system time using the format shown above.

FUNCTION fgetdta&

This function returns the current disk transfer address.

FUNCTION sversion%

A function that returns the TOS version number.

SUB ptermres(BYVAL ret%, BYVAL howmuch&)

This statement calls the GEMDOS terminate and stay resident routine. `ret%` is the return code, `howmuch&` is the number of bytes to keep resident in memory including the basepage. Like any of the other terminate calls, this must not be used from a BASIC program.

SUB dfree(BYVAL buffer&(), BYVAL drive%)

Returns allocation information about `drive%` (0=current drive, 1=A:, 2=B: etc.). The array `buffer&()` will contain four long integers in the following order: free clusters, total clusters, bytes per sector, and sectors per cluster. A statement.

FUNCTION dcreate%(BYVAL dirname$)

This function creates a directory. The value returned is a negative TOS error number if creation failed.

FUNCTION ddelete%(BYVAL dirname$)

Deletes a directory. The value returned is a negative TOS error number if deletion failed. A function.

FUNCTION dsetpath%(BYVAL dirname$

This function sets the current directory.

FUNCTION create%(BYVAL filename$, BYVAL attributes%)

A function that creates a file with the given pathname. Bits in attributes% can be set as shown below:

Bit	Attribute
0	Read Only
1	Hidden
2	System
3	Volume label

If a file has both hidden *and* system attributes, it will become visible from the Desktop; either Hidden *or* System will render the file invisible. The integer returned is the file handle or a negative TOS error number.

FUNCTION fopen%(BYVAL filename$, BYVAL mode%)

This function opens the file specified. mode% can be 0 for read, 1 for write, and 2 for read and write. The integer returned is the file handle or a negative TOS error number.

FUNCTION fclose%(BYVAL handle%)

This function closes a file. handle% is the positive return value from either fcreate% or fopen%.

FUNCTION fread&(BYVAL handle%, BYVAL count&, BYVAL buffer&)

This function reads count& bytes into memory pointed to by buffer&. handle% is the file's handle. The value returned is the actual number of bytes read unless negative, in which case it is a TOS error number.

FUNCTION fwrite&(BYVAL hand6le%, BYVAL count&, BYVAL buffer&)

A function that writes count& bytes from memory pointed to by buffer&. handle% is the file's handle. The value returned is the actual number of bytes written unless negative, in which case it is a TOS error number.

FUNCTION fdelete%(BYVAL filename$)

Deletes the specified file. 0 is returned if successful, a negative value if a TOS error has occurred. A function.

FUNCTION fseek&(BYVAL offset&, BYVAL handle%, BYVAL mode%)

This function seeks within a file. offset& is the number of bytes to seek by. The result is the new file position mode% can be:

Mode	
0	seek from beginning of file
1	seek from current position
2	from end of file

FUNCTION fattrib%(BYVAL filename$, BYVAL mode%, BYVAL attribute%)

This function sets a file's attributes if mode% is 1, or reads them if mode% is 0. The attribute bits are as follows:

Bit	*Attribute*
0	Read Only
1	Hidden
2	System
3	Volume Label
4	Subdirectory
5	Archive bit, set when file is written to & closed

FUNCTION mxalloc&(BYVAL size&, BYVAL mode%)

This is the general call to allocate memory that is available in TOS 2 and above. size& is the number of bytes to allocate and the function returns the address of the area allocated or an error code if it failed. mode% indicates the type of memory to return:

0	System (ST) RAM only
1	Alternative (TT) RAM only
2	System (ST) RAM if available otherwise TT RAM
3	Alternative (TT) RAM if available otherwise ST RAM.

Thus you would use 0 if the memory is going to be used as a physical screen address. Generally 3 is used for memory that you would like to be accessed as quickly as possible.

FUNCTION fdup%(BYVAL handle%)

A function that returns a duplicate handle that refers to the same file or device as handle%.

SUB fforce(BYVAL stdhandle%, BYVAL nonstdhandle%)

A statement that forces stdhandle% to point to same file or device as nonstdhandle%.

SUB dgetpath(BYVAL buffer&, BYVAL drive%)

Returns the current directory in the buffer pointed to by buffer&. The buffer must be at least 64 bytes long. drive% is 0 for the current drive, 1 for A: etc. A statement.

FUNCTION malloc&(BYVAL howmuch&)

This function requests howmuch& memory from the operating system. The return is either an address on a word boundary of howmuch& bytes or 0 if allocation failed. If howmuch& is -1, then the amount of available system memory is returned. All memory allocated with malloc& must be de-allocated with mfree&.

FUNCTION mfree%(BYVAL where&)

Function that returns memory allocated by malloc& to the operating system. where& is the address that was returned by malloc&. A negative TOS error number is returned if an error occurred, otherwise the return value is 0.

FUNCTION mshrink%(BYVAL where&, BYVAL howmuch&)

This function returns memory to the operating system. where& is the beginning of the memory block, howmuch& is the amount of memory to retain. A negative TOS error number is returned upon failure.

FUNCTION pexec%(BYVAL mode%, BYVAL filename$, BYVAL commandline$, BYVAL environment$)

Executes the specified program with the specified parameters. The return value is either a TOS error or the return value passed by the program executed upon termination. This function offers the ability to execute a program and then return. The BASIC RUN and CHAIN statements do not return to the calling program. There is a potentially major problem when using this function: the operating system must have enough memory to run the program (i.e. load it into memory) and there must be enough memory for the called program to run. Consult *Appendix B* and *Chapter 3* of the *User Manual* for details on the KEEP and LEAVE memory allocation options.

SUB pterm(BYVAL return%)

This is another of GEMDOS's terminate calls. return% will be passed back to the process that executed the program. This call must not be used from BASIC.

FUNCTION fsfirst%(BYVAL filename$, BYVAL attributes%)

This function searches for the occurrence of filename$ which has the specified attributes%. filename$ may contain wildcards as long as they are not part of the pathname. 0 is returned if the file was found, -33 if not. The DTA is filled with information about the file:

Bytes	
0-20	GEMDOS internal information
21	File attributes
22-23	File time stamp
24-25	File date stamp
26-29	File size (long integer)
30-43	Name and extension of file, null terminated

FUNCTION fsnext%

This function returns the next occurrence of the file specified by fsfirst%. It must therefore not be used before a fsfirst% call. To be completely safe, do not make any other GEMDOS calls between calls to fsfirst% and any calls to fsnext%.

FUNCTION frename%(BYVAL oldfile$, BYVAL newfile$)

Renames oldfile$ to newfile$. A negative return value is a TOS error. A function.

SUB fdatime(BYVAL handle%, BYVAL buffer&, BYVAL set%)

This statement gets or sets a file's time and date stamp. handle% is the file's handle and buffer& is a pointer to a buffer which contains/will receive the time and date stamp. If set% is 0, the stamp will be returned, if set% is 1, the stamp is set.

The BIOS library

SUB getmpb(BYVAL mpb&())

mpb&() is an array in which three long integers are returned.

This function returns three 32-bit addresses in the array. These addresses are pointers to the memory free list, memory allocated list and the roving pointer.

FUNCTION bconstat%(BYVAL dev%)

dev% is a short integer that specifies the device to be checked.

This function returns the status of the device. 0 is returned if no characters are available, -1 is returned if at least one character is available. dev% may be

0	PRT: the parallel port
1	AUX: the serial port
2	CON: the console
3	MIDI port
4	Keyboard port

FUNCTION bconin&(BYVAL dev%)

dev% is the device from which the character is returned; the values for dev% are the same as for bconstat%.

This function returns a character from the specified device in the low word. If the character is returned from CON: then the high word contains the scancode of the key that was pressed.

FUNCTION bconout%(BYVAL dev%, BYVAL char%)

dev% is the device to which the character is written. char% is the integer ASCII value of the character to be written.

This function writes one character to the specified device. If the device is PRT:, -1 is returned if the character could be written, 0 if the call failed. The function returns only after the character was written or if the device timed out.

FUNCTION rwabs%(BYVAL rwflag%, BYVAL buffer&, BYVAL count%, BYVAL recno%, BYVAL dev%)

rwflag% can be

0	read
1	write
2	read; ignore media change
3	write; ignore media change

buffer& is the address of the buffer. count% is the number of sectors to be read or written. recno% is the logical sector number of the first sector to be read from or written to. dev% is the drive: 0 for drive A:, 1 for drive B: etc.

This function reads from or writes to sectors of the specified drive. 0 is returned if no error occurred; any negative values are TOS error numbers.

FUNCTION setexc&(BYVAL number%)

number% is the vector number to be read.

This function returns the specified 68000 vector. It is not possible to set a vector using this function.

FUNCTION tickcal%

This function returns the time in milliseconds between two system-timer calls.

FUNCTION getbpb&(BYVAL dev%)

dev% is the drive; 0 for drive A:, 1 for drive B: etc.

This function returns a pointer to the BIOS parameter block of the specified drive. The block is defined as follows:

Offset	*Meaning*
0	bytes per sector
2	sectors per cluster
4	bytes per cluster
6	size of root directory in sectors
8	size of FAT in sectors
10	first sector of the second FAT
12	first sector of data
14	number of data sectors on the disk
16	various flags

FUNCTION bcostat%(BYVAL dev%)

dev% is the device to be checked. Valid device numbers are the same as for bconstat%. This function returns -1 if the device is ready to receive data, 0 if it isn't.

FUNCTION mediach%(BYVAL dev%)

dev% is 0 for drive A:, 1 for drive B: etc.

This function returns whether or not the media has been changed in the drive specified. If 0 is returned, the media has definitely not changed. If 1 is returned, status is unsure. If 2 is returned, media has definitely changed.

FUNCTION drvmap%

This function returns a bitmap of the active drives. Bit 0 corresponds to drive A:, bit 1 to drive B: etc.

FUNCTION kbshift%(BYVAL mode%)

If mode% is negative, the status will be returned; if it is non-zero, the bits will be set.

This function returns or sets the status of the Shift keys in a bitmap.

The bits correspond to the following keys:

0	right Shift key
1	left Shift key
2	Ctrl key
3	Alt key
4	Caps Lock

The above is the only way to legally determine the status of the Caps Lock key. All other keys can also be tested by using the AES or VDI.

```
SUB BLOCKMOVE(BYVAL source&, BYVAL dest&,
      BYVAL length&)
```

This moves `length&` bytes of memory from address `source&` to `dest&`. `BLOCKMOVE` isn't an actual XBIOS facility, but is often useful when using these routines.

The XBIOS Library

```
SUB initmous(BYVAL type%, BYVAL param&, BYVAL
      vec&)
```

A sub-program to initialise routines that are executed when the mouse is used.

```
SUB ssbrk(BYVAL amount%)
```

This call has no effect with ROM TOS.

```
FUNCTION physbase&
```

This function returns the the video-RAM's physical base address at the beginning of the next vertical blank.

```
FUNCTION logbase&
```

A function that returns the logical screen base address.

```
FUNCTION getrez%
```

This function returns the current screen resolution, where 0 is low-res, 1 is medium-res, and 2 is high-res (monochrome).


```
SUB setscreen(BYVAL logloc&, BYVAL physloc&,
      BYVAL rez%)
```

A statement that sets the logical screen location (`logloc&`), the physical screen location (`physloc&`), and the resolution (`rez%`). If any of these parameters is negative, the value is not changed. Beware that screen resolution should not be changed with this call after GEM has been initialised.

```
SUB setpalette(BYVAL palette%())
```

This statement sets the entire colour palette (colours 0 to 15). `palette%(0)` should contain the colour value for colour 0 in the palette etc.

```
FUNCTION setcolor%(BYVAL colournum%, BYVAL
      colour%)
```

Sets `colourunum%` in the palette to `colour%`. The old value of the palette register is returned. If `colour%` is negative, the colour is not changed. A function.

```
FUNCTION floprd%(BYVAL buffer&, BYVAL
      dev%,BYVAL sect%, BYVAL trac%, BYVAL
      side%, BYVAL count%)
```

This function reads `count%` sectors from track `trac%`, side `side%` beginning at sector `sect%`, `dev%` is the drive number; A: is 0, B: is 1.

The data from the disk is read into the area in memory specified by `buffer&`. No checks are made that this is memory that can freely be used by the program. The long integer returned is the error number. If it is 0, then the call was completed without error; any negative value returned is a TOS error number.

```
FUNCTION flopwr%(BYVAL buffer&, BYVAL dev%,
      BYVAL s ect%, BYVAL trac%, BYVAL side%,
      BYVAL count%)
```

This function has the same parameters as `floprd%`. The major difference between the two is that `flopwr%` writes the data from `buffer&` to disk.

```
FUNCTION flopfmt%(BYVAL buffer&, BYVAL
      filler&, BYVAL dev%, BYVAL sectrk%,
      BYVAL trac%, BYVAL side%, BYVAL
      interlv%)
```

This function formats a track on a disk. `dev%`, `trac%`, and `side%` are the same as in `floprd%` and `flopwr%`. `buffer&` needs to be a minimum 9k area of free memory, where the XBIOS can prepare the image of the track. `sectrk%` specifies the number of sectors per track; 9 is the TOS standard. `interlv%` is the sector interleave factor which should be specified as 1. If bad sectors are encountered a null terminated list of the bad sectors can be found in the buffer. `filler&` should normally be zero, or point to a skew table if used on a blitter ROM.

```
SUB midiws(BYVAL count%, BYVAL data$)
```

This call writes `data$` to the MIDI port. `count%` is the number of bytes to write.

```
SUB mfpint(BYVAL intno%, BYVAL vector&)
```

This sub-program sets the mfp interrupt `intno%` to point to `vector&`. The old address is over-written.

```
FUNCTION iorec&(BYVAL devno%)
```

A function that returns a pointer to the input buffer record of the specified device. 0 for the serial port, 1 for the keyboard, and 2 for the MIDI port.

```
SUB rsconf(BYVAL speed%, BYVAL flowctl%, BYVAL
      ucr%, BYVAL rsr%, BYVAL tsr&, BYVAL
      scr%)
```

This sub-program sets the configuration of the serial port. If any of the parameters are -1, then that value is not changed.

```
FUNCTION keytbl&(BYVAL unshift&, BYVAL shift&,
      BYVAL capslok&)
```

This function sets the keyboard map to the values pointed at by the three parameters. Any parameter that is -1 will cause that respective table not to be changed. A pointer to the addresses of the three tables is returned. The new tables must be kept in memory that will not be corrupted, otherwise the keyboard layout will become intriguing.

```
FUNCTION random&
```

This function returns a 24-bit random number produced by the XBIOS random number generator.

```
SUB protobt(BYVAL buffer&, BYVAL serial&,
      BYVAL disktype%, BYVAL execflag%)
```

A sub-program that produces a disk boot-sector image in the 512-byte `buffer&`. `serial&` is the 24-bit serial number of the boot disk; if it is greater than or equal to &H1000000, the serial number will be random. `disktype%` can be

0	40 tracks, single sided
1	40 tracks, double sided
2	80 tracks, single sided
3	80 tracks, double sided

If `execflag%` is 1, the boot sector will be made executable; if 0, it will be made non-executable.

If `serial&`, `disktype%`, or `execflag%` are -1, the values will not be changed from those already in the buffer.

```
FUNCTION flopver%(BYVAL buffer&, BYVAL dev%,
      BYVAL sect%, BYVAL trac%, BYVAL side%,
      BYVAL count%)
```

The parameters for this function are identical to those of `floprd%` and `flopwr%`. This function verifies one or more sectors by reading them. `buffer&` must point to a 1024 byte buffer. A null terminated list of the bad sectors is returned in the buffer.

```
FUNCTION scrdmp%
```

Causes a screen dump to be sent to the printer. If the dump occurs without an error, 0 is returned. Otherwise, a negative TOS error number is returned.

```
FUNCTION cursconf%(BYVAL function%, BYVAL
      operand%)
```

This function defines the cursor. `function%` may be

0	hide cursor
1	show cursor
2	set cursor to blink
3	set cursor not to blink
4	set cursor blink to `operand%`
5	return blink timer value

The blink rate depends on the video scan rate (70hz for monochrome). The unit of measure for `operand%` is one-half the cycle time.

SUB settime(BYVAL datetime&)

This statement sets the system clock/calendar. `datetime&` contains time in the low word, date in the high word; both are in DOS format.

FUNCTION gettime&

A function that returns the value of the system clock/calendar. The format is the same as for `settime`.

SUB bioskeys

A statement that resets the keyboard map to the power-up setting. A keyboard initialised by `keytbl&` is reset by this call.

SUB ikbdws(BYVAL count%, BYVAL data$)

Writes `data$` to the intelligent keyboard. `count%` is the number of bytes to write. A statement.

SUB jdisint(BYVAL intno%)

A statement that disables interrupt number `intno%` on the 68901 mfp chip.

SUB jenabint(BYVAL intno%)

Enables interrupt number `intno%` on the 68901 mfp chip. A statement.

FUNCTION giaccess%(BYVAL data%, BYVAL regno%)

This function reads from or writes to a register on the sound chip. `data%` is a byte transferred to the chip, `regno%` is the register number to read; if this value is ORed with &H80 (i.e. bit 7 is set) the register is written to.

SUB offgibit(BYVAL bitno%)

This statement atomically (interrupt mask set to 7) clears `bitno%` in the PORT A register of the sound chip.

SUB ongibit(BYVAL bitno%)

Atomically sets `bitno%` in the PORT A register of the sound chip.

SUB xbtimer(BYVAL timer%, BYVAL control%, BYVAL data%, BYVAL vector&)

A statement that sets up a timer of the 68901 mfp chip. `timer%` can be a number from one to four, corresponding to the timers A to D. `control%` is the timer's control register setting, `data%` is the byte put into the timer's data register; `vector&` is a pointer to the interrupt handler. Timer A is the only timer reserved for user applications, the other three are used by the system.

FUNCTION dosound&(BYVAL pointer&)

Causes the sound daemon to execute the commands at `pointer&`. A function.

FUNCTION setprt%(*config%*)

Sets/returns the printer configuration byte. If `config%` is -1 then the current byte is returned, otherwise it is set with the value of `config%`. The bits are defined as (the other bits of `config%` are reserved and must be cleared):

Bit	*If cleared*	*If set*
0	Dot matrix	Daisy wheel
1	Colour printer	Monochrome
2	Atari printer	Epson compatible
3	Draft mode	Final mode
4	Parallel port	Serial port
5	Form-feed	Single-sheet

FUNCTION kbdvbase&

Returns a pointer to a list of addresses of various buffers and interrupt handlers. A function.

FUNCTION kbrate%(BYVAL initial%, BYVAL repeat%)

This function gets and sets the keyboard repeat rate. `initial%` is the initial delay before repeat sets in; `repeat%` is the rate of repeat. The values are based on 50Hz system ticks. If a parameter is -1, it is not changed.

SUB rtblk(BYVAL listadr&)

This is a primitive used by `scrdmp`. The parameter passed is a pointer to a list of addresses and values.

SUB vsync

This statement returns after the next vblank interrupt. It can be used for synchronizing graphics with the vblank interrupt.

SUB supexec(BYVAL pointer&)

This statement causes the routine at `pointer&` to be executed in supervisor mode. The routine must be terminated with an RTS instruction. This routine should not be used from BASIC.

SUB puntaes

A statement that de-allocates the AES from memory. It has absolutely no effect with ROM TOS.

FUNCTION blitmode%(BYVAL flag%)

This function allows a program to read whether a blitter is connected and being used and turn it on or off. The `flag%` parameter should be -1 to read the configuration, or a new value to set it. The return value is the new configuration, in this binary form:

bit 0	0	use software to blit
	1	use blitter to blit
bit 1	0	no blitter attached (read-only)
	1	blitter attached (read-only)
bits 2-14		reserved
bit 15		must be zero

This call will work on *all* ROM-based versions of the XBIOS.

FUNCTION floprate%(BYVAL devno%, BYVAL newrate%)

This function (introduced with TOS t.0.4) sets the floppy disk drive step rate. `devno%` gives the device number (0=A,1=B). The `newrate%` parameter gives the rate to set in milli-seconds. Alternatively using a rate of -1 will return the current stepping rate for that device.

FUNCTION bconmap&(BYVAL devno%)

This function is used for re-mapping the serial ports on the TT and the MegaSTE.

FUNCTION dmaread&(BYVAL sector&, BYVAL count%, BYVAL buffer&, BYVAL devno%)

This function which was added in TT TOS directly reads `count%` sectors starting at `sector&` from device `devno%` to the buffer at `buffer&`. `devno%` values 0-7 refer to ACSI devices 0-7 and 8-15 refer to SCSI devices 0-7. This function returns a BIOS error code.

FUNCTION dmawrite&(BYVAL sector&, BYVAL count%, BYVAL buffer&, BYVAL devno%)

This function which was added in TT TOS directly writes `count%` sectors starting at sector& from device `devno%` to the buffer at `buffer&`. As a result it should be used with extreme care. `devno%` values 0-7 refer to ACSI devices 0-7 and 8-15 refer to SCSI devices 0-7. This function returns a BIOS error code.

FUNCTION NVMaccess%(BYVAL opcode%, BYVAL start%, BYVAL count%, BYVAL buffer&)

This function is for accessing th Non Volatile Memory in the TT's real time clock chip. The use of this memory will be dictated by Atari; at the time of writing they had not assigned any bytes so perhaps you should talk to them before using this!

FUNCTION EsetShift%%(BYVAL shiftmode%)

This call is used to set the TT's entire video shift register. The meaning of the bits of `shiftmode%` is as shown below:

Bit 15	*Bit 12*	*Bits 10-8*	*Bits 3-0*
Smear Mode	Grey Mode	Screen mode: 000 ST low 001 ST medium 010 ST high 100 TT medium 110 TT high 111 TT low	Current colour bank

If you are only interested in the setting of part of the register it is best to use one of the more specific calls below or in the case of the screen mode `getrez`. `esetshift` was introduced in TT TOS and *requires* the TT video hardware.

FUNCTION EgetShift%

This call is used to return the current state of the TT's video shift register. The meaning of the bits is as shown above. If you are only interested in the setting of part of the register it is best to use one of the more specific calls below. This call was introduced in TT TOS and *requires* the TT video hardware.

FUNCTION EsetBank%(BYVAL bank%)

This call sets the TT's palette bank(if the value is 0-15) or just returns it if the value of `bank%` is negative.

The TT's colour lookup table has 256 entries for use in TT low resolution mode. This call lets you select which bank (collection of 16 entires) will be used in the other modes, thus enabling you to switch between palettes very easily. When setting the bank number, the new bank's colours are copied to the old ST colour mode register. This call was introduced in TT TOS and *requires* the TT video hardware.

FUNCTION EsetColor%(BYVAL colourno%, BYVAL BCDcolour%)

This call is used to read/write a single entry in the TT's colour palette. The colour number should be in the range 0-255 to set the palette or negative to read it. The BCD colour value is encoded as shown below:

bits 15-12	*bits 11-8 (Red)*				*bits 7-4 (Green)*				*bits 3-0 (Blue)*			
Unused	R3	R2	R1	R0	G3	G2	G1	G0	B3	B2	B1	B0

R0 represents the least-significant bit of the red component of the colour, R3 the most-significant. Similarly, G0-G3 give the green component and B0-B3 the blue component.

Note that this (and the other TT specific palette calls) do *not* use the ST compatible method of encoding the colour as per `setcolor` (XBIOS library) and that this call uses the absolute colour number rather than the current bank and so can access all 256 entries. This call was introduced in TT TOS and *requires* the TT video hardware.

SUB EsetPalette(BYVAL colourno%, BYVAL count%, BYVAL buffer&)

This call is used to set the values of the TT's colour lookup table, or palette. The `buffer&` is a pointer to the area to read the palette from; it would normally be part of a BASIC array (accessed via the VARPTR function). `count%` gives the number of colours to change and `colorno%` the first one to modify.

It can be used to set the palette for a single colour, the whole palette or part of it. The colour words are encoded in the standard manner as described under `esetcolor` in this library. This call was introduced in TT TOS and *requires* the TT video hardware.

SUB EgetPalette%(BYVAL colourno%, BYVAL count%, BYVAL buffer&)

This call is used to read the values of the TT's colour lookup table, or palette. The `buffer&` is a pointer to the area to store the palette from; it would normally be part of a BASIC array (accessed via the VARPTR function). `count%` gives the number of colours to read and `colorno%` the first one to use.

It can be used to set the palette for a single colour, the whole palette or part of it. The colour words are encoded in the standard manner as described under `esetcolor` in this library. This call was introduced in TT TOS and *requires* the TT video hardware.

FUNCTION EsetGray%(BYVAL switch%)

This call is used to read/write the TT video hardware's grey mode bit. Use a `switch%` value of 0 for colour mode, 1 for grey mode or a negative value to read the value. This function returns the old grey mode bit setting.

When grey mode is set, the bottom eight bits of the palette value are used as one of 256 possible grey levels. The best way to see the effect of this is using the Colour part of the Control Panel (just click on the Grey button). This call was introduced in TT TOS and *requires* the TT video hardware.

FUNCTION EsetSmeat%(BYVAL switch%)

This call is used to read/write the TT video hardware's smear mode bit. Use a `switch%` value of 0 for normal, positive for smear mode or a negative value to read the value. This function returns the old smear mode bit setting.

When smear mode is set, the video hardware displays video pixels with value 0 as the last non-zero colour rather than colour zero itself. This can be used to change the colour of a filled-polygon by only changing its outline rather than via a complete re-fill. This call was introduced in TT TOS and *requires* the TT video hardware.

STESOUND library

This library uses the STE sound hardware which is also available on the TT. Before using this library you should check that the appropriate hardware is present using:

```
IF (GETCOOKIE("_SND") AND 2) = 0 THEN
PRINT "Sorry this program requires DMA SOUND hardware"
   STOP -1
```

SUB DMAcontrol(BYVAL newvalue%)

This sets the STE sound hardware's control register. The appropriate values are:

0	Disable DMA sound
1	Do sound once
3	Do sound repeatedly

```
SUB DMAsound(BYVAL startadr&, BYVAL endadr&,
    BYVAL mode%)
```

This sets the start and end addresses of the sample address for the DMA sound hardware together with the sound mode. The `mode%` gives the sample rate (see the table below) and also whether mono or stereo is to be used. Add 128 in the values in the table for mono.

0	6258Hz
1	12517Hz
2	25033Hz
3	50066 Hz

```
SUB MWout(BYVAL mask%,BYVAL data%)
```

Writes the values `mask%` and `data%` to the STE MICROWIRE interface. The full generality of this is not used, but it can be used to set the volume/tone and mixing of the STE DMA sound at present. This command issues the command immediately but waits for the command to be complete before returning.

The GEMVDI library

The GEM VDI library contains routines to access all the VDI routines except the Escape codes. The names of these routines are based on the standard C names for the functions and are listed in the same order as in the Digital Research documentation. This library forces the output to be a GEM program and also ensures that underlines are allowed in variable names.

In the following description, it is assumed that you have used `defint a-z`. Otherwise you must type `%` at the end of all the function and parameter names that do not have an explicit type.

Most of the parameters are passed by value; those that are not are prefaced with the keyword `varptr`. Naturally the keyword varptr is not used when calling the sub-program or function. Generally you should give these a simple variable name to store the returned value. If you are not interested in a particular value just pass 0; the result will then be ignored.

Note that the VDI handle is not passed to the individual routines. This is normally assumed to be the handle used by the run-time system but can be changed used the special `CHANGE_HANDLE` call below. You also do not normally need to open or close a Virtual Workstation; the run-time system does this for you.

We have included functions that we have tested to work on standard STs with the operating system in ROM and also tested additional features available with Atari GDOS version 1.1. Where applicable the following documentation notes when GDOS is required. All these routines use the same pseudo-arrays that the ST BASIC style facilities use.

Note that if you call GEM VDI using these routines and then call the BASIC routines built into the runtimes such as `CLS` and `LINEF`, then strange effects may occur.

If you haven't used the VDI before (or if you have only dabbled) the number of functions can be intimidating. However they are grouped into 'families' and can generally be identified by the first letters of their names. Routines starting with

v_	generally do things immediately such as draw circles
vs	generally set variables
vq	return the current settings of variables.
vr	raster routines.

Most of the GEM VDI routines that draw graphics use a particular set of variables to determine what is drawn, either the line, text, fill area or marker attributes. These are listed below together with the names of the routines which set them:

The *line* attributes:

line type (`vsl_type`), line colour index (`vsl_color`), line width (`vsl_width`) and end style (`vsl_ends`).

Note that all these routines start with `vsl_`.

The *text* attributes:

text alignment (`vst_alignment`), colour (`vst_color`), height (`vst_height` and `vst_point`), rotation (`vst_rotation`), font (`vst_font`) and special effects (`vst_effects`).

Note that all these routines start with `vst_`.

The *fill area* attributes:

fill area colour (`vsf_color`), fill style (`vsf_interior`), fill style index (`vsf_style`) and perimeter visibility (`vsf_perimeter`).

The *marker* attributes:

marker colour (`vsm_color`), marker height (`vsm_height`) and marker type (`vsm_type`). Note that all these routines start with `vsm_`.

Angles are measured from 0 to 3600 anti-clockwise with zero being the positive x axis. VDI rectangles are specified using the top left and bottom right corners.

GEMVDI : Control

These functions can be ignored if you are new to using the VDI.

FUNCTION GDOS

returns true (-1) if the program is running under GDOS. This means that the program can load fonts and open workstations. `GDOS` returns 0 if GDOS is missing. If you are writing a program to run under GDOS check that it is there at the beginning of your program; otherwise the machine may crash when you load fonts.

FUNCTION CVHANDLE

returns the current handle being used by this library. Should be saved before opening a physical or virtual workstation.

SUB CHANGE_HANDLE(BYVAL handle)

modifies the handle used by this library to be `handle`.

FUNCTION RESOLUTION

although not really a VDI function it can be useful when opening a GDOS workstation returns the current screen resolution according to the following table:

This is obtained via the XBIOS `getrez` call.

SUB v_opnwk(BYVAL inv(), handle, BYVAL outv())

This routine attempts to open a workstation. Do not use it unless you have GDOS installed; otherwise the machine will crash. The workstation handle allocated is returned in `handle` or is 0 if the device cannot be opened. The handle returned also becomes the current handle for the other routines in this library to use.

When using this routine you must ensure that there is sufficient system memory to load the driver using the Keep and Leave options. `inv()` specifies the device to open and various initial values for variables as follows on the next page:

`inv(0)`	the device id number as used in the `ASSIGN.SYS` file.
`inv(1)`	line type
`inv(2)`	line colour
`inv(3)`	marker type
`inv(4)`	marker colour
`inv(5)`	text font
`inv(6)`	text colour
`inv(7)`	fill area interior
`inv(8)`	fill area style index
`inv(9)`	fill area colour

`inv(10)`	NDC to RC transformation flag: 2 use device (pixel) co-ordinates; 0 use normalised co-ordinates 0-32767.

The `outv()` array gives information concerning the facilities available on the device. It must have at least 57 elements.

SUB v_clswk

closes the current workstation. You must call this for each workstation that you open. This causes the page to output to printer devices. You should follow this with a `CHANGE_HANDLE` call. Do not attempt to close the run-time system's workstation with this call.

SUB v_opnvwk(BYVAL inv(), handle, BYVAL outv())

This attempts to open a new virtual workstation for the device with handle given in `handle` and returns the new handle in `handle`. The parameters are the same as the `v_opnwk` call with the exception of `handle` which must be set up before calling this routine. If using GDOS the handle to pass is returned by the `v_opnwk` call above. When not using GDOS, `v_opnvwk` can also be used to have different clipping rectangles, fill patterns etc on the screen at once without the need to change all the variables.

In this case make sure that `handle` is 1 before calling this routine. Zero is returned in handle if the device cannot be opened. The handle returned becomes the new handle to be used by the rest of this library. If you are not using GDOS you can *not* use NDC co-ordinates; you *must* give `inv(10)` as 2.

SUB v_clsvwk

closes the current virtual workstation. You must call this for each virtual workstation that you open yourself. You should follow this with a `CHANGE_HANDLE` call.

SUB v_updwk

This routine updates the current workstation. Not applicable to screens, but will cause a printer or plotter to output the current page.

SUB v_clrwk

This routine clears the current workstation (usually the screen).

FUNCTION vst_load_fonts

Loads fonts into GEMDOS free memory and returns the number of fonts loaded as the result. This call only works when GDOS is installed; otherwise the machine may crash. The amount of GEMDOS free memory may be increased using the compiler's Keep and Leave options. See *Appendix B* and *Chapter 3* of the *User Manual*. These options let you leave more memory to load fonts.

SUB vst_unload_fonts

Unloads fonts that were loaded using `vst_load_fonts`. This *must* be called if you have used `vst_load_fonts` before the Virtual Workstation is closed. The default Virtual Workstation is closed by the run-rime system when a program terminates.

SUB vs_clip(BYVAL flag, BYVAL x1, BYVAL y1, BYVAL x2, BYVAL y2)

If `flag=0` then switches VDI clipping off; otherwise sets the clip rectangle to be (x1,y1) to (x2,y2).

GEMVDI : Drawing Primitives

SUB v_pline(BYVAL n, BYVAL pts())

Draws a series of lines between `n` points. The points are passed in the array `pts()` with `pts(0)` containing the first x co-ordinate; `pts(1)` the first y co-ordinate; `pts(2)` the second x co-ordinate; `pts(3)` the second y co-ordinate etc. `n` must be at least two. The *line* attributes are used.

SUB v_pmarker(BYVAL n, BYVAL pts())

Draws a series of markers at `n` points. The points are passed in the array `pts()` with `pts(0)` containing the first x co-ordinate; `pts(1)` the first y co-ordinate; `pts(2)` the second x co-ordinate; `pts(3)` the second y co-ordinate etc. `n` must be at least one. The *marker* attributes are used.

SUB v_gtext(BYVAL x, BYVAL y, BYVAL text$)

Writes the graphics text `text$` to the display at (x,y). The *text* attributes are used.

SUB v_fillarea(BYVAL n, BYVAL pts())

Fills a polygon given `n` points. The points are passed in the array `pts()` with `pts(0)` containing the first x co-ordinate; `pts(1)` the first y co-ordinate; `pts(2)` the second x co-ordinate; `pts(3)` the second y co-ordinate etc. `n` must be at least two. The first point is connected to the last point; there is no need to specify the first point twice. The *fill area* attributes are used.

SUB v_contourfill(BYVAL x, BYVAL y, BYVAL colour)

Seed fills an area starting with (x,y) in the colour given by `colour`. If `colour` is negative the algorithm searches for any colour other than that specified. The *fill area* attributes are used.

SUB vr_recfl(BYVAL x1, BYVAL y1, BYVAL x2, BYVAL y2)

fills the rectangle given by the points (x1, y1) and (x2,y2). Uses the *fill area* attributes except that no box is drawn aronnd it whatever the value given to `vsf_perimeter`.

SUB v_bar *x1, y1, x2, y2*

fills the rectangle using the *fill area* attributes and surrounds it with a box in the current *fill area* colour if `vsf_perimeter` has been set to 1.

SUB v_arc(BYVAL x, BYVAL y, BYVAL r, BYVAL start_angle, BYVAL end_angle)

draws an arc using the *line* attributes centred on (x,y) of radius `r` starting with angle `start_angle` and ending with angle `end_angle`.

SUB v_pieslice(BYVAL x, BYVAL y, BYVAL r, BYVAL start_angle, BYVAL end_angle)

draws a pie slice using the *fill area* attributes centred on (x, y) of radius `r` starting with angle `start_angle` and ending with angle `end_angle`.

SUB v_circle(BYVAL x, BYVAL y, BYVAL r)

draws a circle using the *line* attributes centred on (x,y) of radius `r` .

```
SUB v_ellarc(BYVAL x,BYVAL  y,BYVAL  xr,BYVAL
    BYVAL yr, BYVAL start_angle, BYVAL
    end_angle)
```

draws an elliptical arc using the *line* attributes centred on (x,y) with x radius xr and y radius yr starting with angle start_angle and ending with angle end_angle.

```
SUB v_ellpie(BYVAL x, BYVAL y, BYVAL xr, BYVAL
    yr, BYVAL start_angle, BYVAL end_angle)
```

draws an elliptical pie slice using the *fill area* attributes centred on (x,y) with x radius xr and y radius yr starting with angle start_angle and ending with angle end_angle.

```
SUB v_ellipse(BYVAL x, BYVAL y, BYVAL xr,
    BYVAL yr)
```

draws an ellipse using the *line* attributes centred on (x,y) with x radius xr and y radius yr .

```
SUB v_rbox(BYVAL x1, BYVAL y1, BYVAL x2, BYVAL
    y2)
```

draws a box with rounded edges using the *line* attributes with co-ordinates (x1,y1) to (x2,y2).

```
SUB v_rfbox(BYVAL x1, BYVAL y1, BYVAL x2,
    BYVAL y2)
```

draws a filled rectangle with rounded edges using the *fill area* attributes with co-ordinates (x1,y1) to (x2,y2).

```
SUB v_justified(BYVAL x, BYVAL y, test$, BYVAL
    length , BYVAL wordflag, BYVAL charflag)
```

draws the justified text test$ at (x,y) in pixel width of length. If wordflag and charflag are non-zero then GEM VDI may adjust the word and character spacing. So to only adjust the word (not the character) spacing use wordflag=1 and charflag=0. The text attributes are used.

GEMVDI: Attributes

```
SUB vswr_mode(BYVAL mode)
```

Sets the current writing mode that is used in all the drawing routines to be mode. The different modes are

Number	*Mode*
1	Replace
2	Transparent
3	XOR
4	Reverse transparent

```
SUB vs_color(BYVAL index, BYVAL r, BYVAL g,
    BYVAL b)
```

Sets the colour numbered index to be the nearest possible to red, green and blue intensities given by r, g and b. Intensities vary from 0 to 1000. The default colour indices.depend on whether you have used the Control Panel or the PALETTE statement. If you have modified the colours using the Control Panel you will obviously get the colours that you have set. However simply running the Control Panel also has the effect of changing the colours that are used in Low resolution.The PALETTE statement also sets these colours:

Number	*With Control Panel*	*Without*
0	White	White
1	Black	Black
2	Red	Red
3	Green	Green
4	Blue	Blue
5	Dark blue	Cyan
6	Brown	Yellow
7	Dark Green	Magenta
8	Grey	Light Grey
9	Dark Grey	Dark Grey
10	Light Blue	Light Red
11	Blue Green	Light Green
12	Light Purple	Light Blue
13	Dark Purple	Light Cyan
14	Dark Yellow	Light Yellow
15	Light Yellow	Light Magenta

SUB vsl_type(BYVAL type)

sets the line `type` to be one of

type	*action*
1	solid
2	long dash
3	dot
4	dash dot
5	dash
6	dash, dot, dot
7	user defined style set by `vsl_udsty` (see below)

This is one of the *line* attributes.

SUB vsl_udsty(BYVAL pattern)

sets the user defined line style (see `vsl_type` above) to be given by the integer parameter. The bits from this word are repeated when drawing the line so that `&hFFFF` (all bits set) corresponds to a solid line, `&hFFF0` (first 12 bits set last 4 reset) corresponds to long dashes etc.

SUB vsl_width(BYVAL width)

sets the line width to `width` pixels. `width` should be odd; if an even number is given then one less than this is used. This is one of the *line* attributes.

SUB vsl_color(BYVAL colour)

sets the current line colour index to be the `colour` index specified. If this is too large then colour index one is used. This is one of the line attributes. For the default values for the colour indices and how to change them see `vs_color` above.

SUB vsl_ends(BYVAL beginstyle, BYVAL endstyle)

Sets the styles for the beginning and end of lines to be `beginstyle` and `endstyle` respectively. The values for styles are as follows:

0	square (default)
1	arrow
2	rounded

This is one of the *line* attributes.

SUB vsm_type(BYVAL type)

sets the marker `type` to be one of

Number	*Type*
1	dot
2	plus
3	asterisk
4	square
5	Diagonal cross
6	Diamond

This is a *marker* attribute.

SUB vsm_height(BYVAL height)

Attempts to set the marker height to `height`. If the given value is not possible then the next smallest height is set and returned with the x value in `ptsout` and the y value in `ptsout+2`. This is a *marker* attribute.

SUB vsm_color(BYVAL colour)

sets the current marker colour index to be the `colour` index specified. If this is too large then colour index 1 is used. This is one of the *marker* attributes. For the default values for the colour indices and how to change them see `vs_color` above.

SUB vst_height(BYVAL height)

Attempts to set the text height to `height`. If the given value is not possible then the next smallest height is set. Returned in `ptsout` is the width of the widest character in the font. `ptsout+2` contains the height of the highest character in the font. `ptsout+4` and `ptsout+6` contain the dimensions of the cell in which such characters are drawn. This is a *text* attribute function.

SUB vst_point(BYVAL points)

Attempts to set the text height in points to `points` . If the given value is not possible then the next smallest point size is set and returned in `intout`. Returned in `ptsout` is the width of the widest character in the font in pixels. `ptsout+2` contains the height of the highest character in the font in pixels. `ptsout+4` and `ptsout+6` contain the dimensions of the cell in which such characters are drawn. This is a *text* attribute function.

SUB vst_rotation(BYVAL angle)

Attempts to set the orientation of the text that is drawn. `angle` should be one of

angle	*effect*
0	Normal
900	Up the page
1800	Upside down
2700	Down the page

Don't pass an angle greater than 3150; bus errors may result. This is a *text* attribute function.

SUB vst_font(BYVAL font)

Sets the current `font`. The standard system font is font 1. To load other fonts you need GDOS. To find the names and indices of font use `vqt_name`. This is a *text* attribute function.

SUB vst_color(BYVAL colour)

sets the current text colour index to be the `colour` index specified. If this is too large then colour index one is used. This is one of the *text* attributes. For the default values for the colour indices and how to change them see `vs_color` above.

SUB vst_effects(BYVAL effects)

Sets the special effects that are used when drawing text. `effects` is a bit map with masks if set having effects as follows

Mask	*Action*
1	Thickened
2	Grey (not bright)
4	Skewed (like italic)
8	Underlined
16	Outline
32	Shadowed

This is a *text* attribute function.

SUB vst_alignment(BYVAL horizontal, BYVAL vertical)

Sets the alignment that is used when text is drawn. This is where the given co-ordinate refers to when using `v_gtext`. `horizontal` may have the following values:

value	*effect*
0	left justified (default)
1	centre justified
2	right justified

`vertical` may have the following values:

value	*effect*
0	base line (default). The bottom of characters without descenders.
1	half line. The top of lower case letters such as a and e.
2	ascent line. The top of upper case letters such as A and E.
3	bottom. The very bottom of the character cell.
4	descent. The bottom of characters with descenders such as g and y.
5	top. The very top of the character cell.

This is a *text* attribute function.

SUB vsf_interior(BYVAL fill_interior)

This sets the fill style to be one of the following according to `fill_interior`:

Style	*Effect*
0	hollow
1	solid
2	pattern
3	hatch
4	user-defined style

For values 2 and 3 this is used in conjunction with the style index set by `vsf_style`. The user-defined style is set using `vsf_updat` and is an Atari logo by default. This is a *fill area* function and can also be set using the `COLOR` statement.

SUB vsf_style(BYVAL style_index)

Sets the current `style_index` to be used in conjunction with the pattern and hatch fill interiors. This is a *fill area* function and can also be set using the `COLOR` statement.

See the `COLOR` statement in *Command Reference* for the fill styles.

SUB vsf_color(BYVAL colour)

sets the current fill area colour index to be the `colour` index specified. If this is too large then colour index one is used. This is one of the *fill area* attributes. For the default values for the colour indices and how to change them see `vs_color` above.

SUB vsf_perimeter(BYVAL flag)

If flag is non-zero then filled areas are surround by a perimeter using the current line attributes. This is the default. If `flag=0` then no perimeter is drawn. This is a *fill area* function.

```
SUB vsf_updat(BYVAL plane(), BYVAL planes)
```

Sets the user definable fill pattern that is selected using `vsf_interior`. `planes` gives the number of planes in the fill pattern (for monochrome this is one). Any unspecified planes are zeroed when filling takes place. The pattern is passed in the array `plane()` with 16 words for each plane. The first word (element zero in the array) gives the bit pattern for the top line and the last one the bottom line. Within each word the most significant bit gives the left most pixel. This is a *fill area* function.

GEMVDI: Raster Functions

```
SUB vro_cpyfm(BYVAL mode, BYVAL xy(), BYVAL
      source&, BYVAL dest&)
```

This performs an opaque raster copy with the source rectangle specified in `xy(0)` to `xy(3)` and the destination rectangle in `xy(4)` to `xy(7)`. `source&` is the source Memory Form Definition Block (MFDB) and `dest&` is the destination MFDB. Note that the device dependent form appears always to be used by current versions of the operating system, regardless of the indicated mode. `mode` specifies the operation performed. In the table below `S` is the source value and `D` the destination value.

mode	*new value*	
0	0	
1	S AND D	
2	S AND (NOT D)	
3	S	replace
4	(NOT S) AND D	erase
5	D	
6	S XOR D	XOR
7	S OR D	
8	NOT (S OR D)	
9	NOT (S XOR D)	
10	NOT D	
11	S OR (NOT D)	
12	NOT S	
13	(NOT S) OR D	
14	NOT (S AND D)	
15	1	

The main differences between the built-in `GET` and `PUT` statements and the facilities available via this function are that no clipping is performed and you can move directly on screen without going via an array.


```
SUB vrt_cpyfm(BYVAL mode, BYVAL xy(), BYVAL
      source&, BYVAL dest&, BYVAL foreground,
      BYVAL background)
```

This performs a raster copy from a monochrome raster block with the source rectangle specified in `xy(0)` to `xy(3)` to a colour block with destination rectangle in `xy(4)` to `xy(7)`. `source&` is the source Memory Form Definition Block (MFDB) and `dest&` is the destination MFDB. `mode` specifies the operation performed and is given by the following table:

Number	*Mode*
1	Replace
2	Transparent
3	XOR
4	Reverse transparent

`foreground` and `background` specify the corresponding colours to be used in the destination block.

```
SUB v_get_pixel(BYVAL x, BYVAL y, value,
      index)
```

Gives the value of the pixel and (x,y) in `value` and the colour index corresponding to this in `index`. Normally `index` and `value` are the same.

GEMVDI: Mouse & Keyboard State Functions

```
SUB v_show_c(BYVAL flag)
```

Shows the graphics cursor on the screen; unless `flag<>0` and `v_hide_c` has been called more than once previously. If `flag<>0` and `v_hide_c` has been called *n* times then you must call `v_show_c` *n* times before the mouse is displayed again. If `flag=0` the mouse is displayed regardless of the number of calls to `v_hide_c`.

```
SUB v_hide_c
```

Removes the mouse from the screen.

SUB vsc_form(BYVAL inv())

Sets the current shape of the mouse. The elements of the array `inv()` are as follows:

`inv(0)`	x co-ordinate of hot spot.
`inv(1)`	y co-ordinate of hot sport
`inv(2)`	reserved must be 1
`inv(3)`	mask colour index normally 0
`inv(4)`	data colour index normally 1
`inv(5)-inv20)`	bitmap for mouse mask
`inv(21)-inv(36)`	bitmap of mouse data

SUB vq_mouse(button, x, y)

Returns the current position of the mouse in (`x`,`y`) and which mouse buttons are down in `button`. Bit 0 of `button` is 1 if the left button is down and bit 1 is down if the right button is down.

SUB vq_key_s(kstate)

returns the current state of the Shift keys in `kstate` as a bit map with the bit set if the corresponding key is down:

Bit	*Mask*	*Meaning*
0	1	Right Shift
1	2	Left Shift
2	4	Control
3	8	Alt Key

GEMVDI: Enquires

SUB vq_extnd(BYVAL flag, BYVAL info())

Returns information about the current VDI variables. If `flag=0` then the Open Workstation values are returned and if `flag=1` the Extended Inquire values are returned. `info()` must have at least 57 elements. The values returned are too numerous to list here. `info(0)` to `info(44)` contain the values returned in `intout` and `info(45)` to `info(56)` contain the values in `ptsout`.

SUB vq_color(BYVAL colour_index, BYVAL flag, BYVAL rgb())

returns the red, green and blue intensities for `colour_index` in `rgb(0)`, `rgb(1)` and `rgb(2)` respectively. If `flag=0` the values that the device gives are returned. If `flag=1` then the values that the user last requested are given.

SUB vql_attributes(BYVAL info())

returns the current *line* attributes as follows

`info(0)`	line type (set with `vsl_type`)
`info(1)`	line colour (set with `vsl_color`)
`info(2)`	writing mode (set with `vswr_mode`)
`info(3)`	start point end style (set with `vsl_ends`)
`info(4)`	end point end style (set with `vsl_ends`)
`info(5)`	line width (set with `vsl_width`)

SUB vqm_attributes(BYVAL info())

returns the current *marker* attributes as follows

`info(0)`	marker type (set with `vsm_type`)
`info(1)`	marker colour (set with `vsm_color`)
`info(2)`	writing mode (set with `vswr_mode`)
`info(3)`	not used
`info(4)`	marker height (set with `vsm_height`)

SUB vqf_attributes(BYVAL info())

returns the current *fill area* attributes as follows

`info(0)`	fill area interior style (set with `vsf_interior`)
`info(1)`	fill area colour (set with `vsf_color`)
`info(2)`	fill area style (set with `vsf_style`)
`info(3)`	writing mode (set with `vswr_mode`)
`info(4)`	fill perimeter status (set with `vsf_perimeter`)

SUB vqt_attributes(BYVAL info())

returns the current *text* attributes as follows:

`info(0)`	current font (set with `vst_font`)
`info(1)`	text colour (set with `vst_color`)
`info(2)`	text rotation base line (set with `vst_rotation`)
`info(3)`	horizontal alignment (set with `vst_alignment`)
`info(4)`	vertical alignment (set with `vst_alignment`)
`info(5)`	writing mode (set with `vswr_mode`)
`info(6)`	max. char. width (set implicitly via `vst_height` or `vst_point`)
`info(7)`	max. char. height (set implicitly via `vst_height` or `vst_point`)
`info(8)`	max. cell width (set implicitly via `vst_height` or `vst_point`)
`info(9)`	max. cell height (set implicitly via `vst_height` or `vst_point`)

SUB vqt_extent(BYVAL text$, BYVAL info())

Returns in info() the co-ordinates of a box needed to enclose the text string text$ if written using the current text attributes. This is used when writing text using different heights, fonts, effects etc. The co-ordinates returned are

info(0) & info(1)	bottom left
info(2) & info(3)	bottom right
info(4) & info(5)	top right
info(6) & info(7)	top left

SUB vqt_width(BYVAL char, cellwidth, left, right)

Returns the width of the cell that the character char uses with the current text attributes in cellwidth; together with number of blank pixels the space to the left in left and the number of blank pixels to the right in right.

FUNCTION vqt_name(BYVAL number, name$)

Returns as the result of the function the font index used in vst_font from number in the range 1 to the number of fonts. Also returned is the name of the font in name$.

SUB vqt_fontinfo(firstchar, lastchar, BYVAL distances(), maxwidth, BYVAL effects())

Returns information on the current font. firstchar and lastchar give the range of characters available. distances() returns information on the size of the characters as the distances between the following lines and the base line (the bottom of characters without descenders).

distances(0)	very bottom of the cell descenders
distances(1)	bottom of characters with descenders
distances(2)	the top of normal lower case letters
distances(3)	the top of upper case letters
distances(4)	the top of the cell

maxwidth is the maximum cell width not including any special effects.

effects()	contains information on the effect of the current special effects set using vst_effects as follows:
effects(0)	additional pixels in the x direction
effects(1)	the number of pixels that the left hand of the character cell is slanted at the baseline.
effects(2)	the number of pixels that the top right is slanted relative to the base line.

The GEMAES Library

The GEMAES library lets you use the user-interface facilities of GEM such as menus and dialog boxes. As with the VDI there are a large number of routines, but these are divided into families. Unfortunately many of the routines use data structures which are too numerous to describe here. See the books on GEM described in the *Bibliography* in the *User Manual*.

The names of these routines are based on the standard C names for the functions and are listed in the same order as in the Digital Research documentation. This library forces the output to be a GEM program and also ensures that underlines are allowed in variable names.

As with the GEM VDI library, in the following descriptions, it is assumed that you have used defint a-z. Otherwise you must type % at the end of all the function and parameter names that do not have an explicit type.

Most of the parameters are passed by value; those that are not are prefaced with the keyword varptr. This does not mean that the keyword varptr is specified when calling the sub-program or function. Generally you should give these a simple variable name to store their values. If you are not interested in a particular value just pass 0; the result will then be ignored.

To help you use the GEMAES data structures there is a file called GEMAES.BH on your master disk which contains most of the constant definitions you need. This takes a few seconds to compile, but saves you the trouble of looking up their values. Hopefully it will also encourage you to make your programs more readable by using these constants rather than the actual numbers.

One way in which the AES differs from the VDI is that rectangles are passed as x, y, w and h. (x,y) gives the top left corner; w the width and h the height. The AES uses window handles which are not the same as VDI handles.

Please see the next chapter and the example programs on the disks for examples of the use of these functions.

When using the HiSoft BASIC WINDOW commands the run-time system will 'steal' any update messages that would normally be generated, so if you are calling the GEM AES window handling routines directly then you should use WINDOW OFF to stop this.

To remove the window that the run-time system opens when a program starts running use WINDOW CLOSE, or to stop it opening at all use the Window Defeat option, described in *Appendix B* and *Chapter 3* of the *User Manual*.

You may use resource files with HiSoft BASIC; please see the rsrc_load call and the next chapter for more details.

GEMAES: Utility routine

```
SUB INTERSECTION(BYVAL  x1, BYVAL y1, BYVAL
      w1, BYVAL h1, BYVAL x2, BYVAL y2, BYVAL
      w2, BYVAL h2, x, y, w, h)
```

When using the AES windows in conjunction with desk accessories you often need to find the intersection of two rectangles so you know what you need to update. This routine returns in (x, y, w, h) the intersection of the two rectangles (x1, y1, w1, h1) and (x2, y2, w2, h2).

GEMAES: Message Passing

```
SUB appl_read(BYVAL ap_id, BYVAL length, BYVAL
      message&)
```

Reads `length` bytes from the message pipe of the application with identifier `ap_id` into the buffer pointed to by `message&`. The `ap_id` is normally that of the program itself obtained from the global array pointed to by `GB`.

```
SUB appl_write(BYVAL ap_id, BYVAL length,
      BYVAL message&)
```

Writes `length` bytes to the message pipe of the application with identifier `ap_id` from the buffer pointed to by `message&`, The `ap_id` is normally that of a desk accessory obtained using the `appl_find` call below. To use this effectively you need to know full technical details of the desk accessory.

```
FUNCTION appl_find(BYVAL name$)
```

returns the identifier of the application called `name$` for use with the `appl_write` statement. There is no need to ensure that `name$` is 8 characters long and padded with spaces; the library routine will do this for you.

GEMAES: Events

```
FUNCTION evnt_keybd
```

returns the next key pressed in a unique form. The low byte is the ASCII value and the high byte is the scan code for the key unless `CTRL` is held down together with cursor left, cursor right or `clr/home` keys when `&h73`, `&h74` and `&h77` are returned in the high byte respectively.


```
FUNCTION evnt_button(BYVAL clicks, BYVAL mask
      ,BYVAL state, xout, yout, button,
      kstate)
```

This function waits for a particular mouse button state. `clicks` is the maximum number of clicks that the application is waiting for. The number of clicks that actually occurred (between 1 and `clicks` inclusive) is returned as the result of the function. `mask` ,`state` and `button` use a bit mask for the state of the button. Bit 0 is the left button and bit 1 is the right button. A value of 0 means the button is up and 1 means the button is down, The button state is ANDed with mask and tested to be equal to state. The state of all the buttons is returned in `button`. `x` and `y` give the position of the mouse when the event occurred and `kstate` gives the state of the Shift keys. With the following bits giving the state:

Mask	*Key*
1	right Shiff
2	left Shiff
4	Ctrl
8	Alt

As usual a bit is 0 if the key is up and 1 if the key is down.

```
SUB evnt_mouse(BYVAL flag, BYVAL x, BYVAL y,
      BYVAL w, BYVAL h, xout, yout, button,
      kstate)
```

Waits for the mouse to enter or leave a rectangle given by `(x,y)` with width `w` and height `h`. If `flag=0` then the routine returns on entry else if `flag=1` it returns on exit. The position of the mouse when the event occurs is given in `(xout,yout)` and the state of the mouse buttons and Shift keys are given in `button` and `kstate` as defined in `evnt_button` immediately above.

```
SUB evnt_mesag(BYVAL message&)
```

Waits for a message in the applications message pipe and places this in the buffer pointed to by `message&`. This must be at least 16 bytes long.

```
SUB evnt_timer(BYVAL time&)
```

Waits for `time&` milliseconds to pass.

```
FUNCTION evnt_multi(BYVAL eflags, BYVAL
      clicks, BYVAL mask, BYVAL state, BYVAL
      flag1, BYVAL x1, BYVAL y1, BYVAL w1,
      BYVAL h1, BYVAL flag2, BYVAL x2, BYVAL
      y2, BYVAL w2, BYVAL h2, BYVAL message&,
      BYVAL time&, xout, yout, button, kstate,
      key_pressed, gotclicks)
```

Waits for a combination of events to occur. The events are given as a mask in `eflags` with the following mask values:

Mask	Name
1	MU_KEYBD
2	MU_BUTTON
4	MU_M1
8	MU_M2
16	MU_MESAG
32	MU_TIMER

These constants are defined in the `GEMAES.BH` file. The parameter `key_pressed` is the key pressed as returned by `evnt_keybd`. `clicks`, `mask`, `state`, `xout`, `yout`, `button` and `kstate` and defined under `evnt_button`. The value that would be returned by `evnt_button` is returned in `gotclicks`. `message&` is defined under `evnt_mesag` and `time&` under `evnt_timer`. `flag1`, `x1`, `y1`, `w1`, `h1` and the corresponding parameters with `2` refer to two distinct rectangles as defined under `evnt_mouse`. The value returned is a mask of the event(s) that actually occurred as specified in the table above. Note that more than one event may be returned at once.

```
FUNCTION evnt_dclick(BYVAL newvalue, BYVAL
      setorget)
```

This routine sets or gets the double click speed of the mouse. If `setorget=1` then the speed is set according to `newvalue` and it is returned as the result of the function if `setorget=0`. The values used are between 0 and 4 and correspond to the values on the `Control Panel`.

GEMAES: Menus

```
SUB menu_bar(BYVAL tree&, BYVAL flag)
```

Displays a menu bar represented by the object tree pointed to by `tree&` if `flag=1` and "removes" the menu bar if `flag=0`. In general it is easier to use the `MENU` function (see above) to display menus. `tree&` must point to a valid menu tree as produced by a resource construction set or `MENU` call. If you use this sub-program to display a menu then you should remove it before your program finishes. Note that removing an item does not cause the menu bar to be cleared.

```
SUB menu_icheck(BYVAL tree&, BYVAL item, BYVAL
      flag)
```

Displays a tick (check mark) by the menu `item` in the menu object tree `tree&` if `flag=1`. If `flag=0` then the tick is erased. If you have used the `MENU` function to display the menu bar then the `tree&` is the value returned by the function call. The `item` number is calculated as described under the `MENU` function.

```
SUB menu_ienable(BYVAL tree&, BYVAL item,
      BYVAL flag)
```

Dims a menu `item` in the menu object tree `tree&` if `flag=0`. If `flag=1` then the item is displayed in full brightness. If you have used the `MENU` function to display the menu bar then the `tree&` is the value returned by the function call. The `item` number is calculated as described under the `MENU` function.

```
SUB menu_tnormal(BYVAL tree&, BYVAL title,
      BYVAL flag)
```

Displays a menu `title` in reverse video from the menu object tree `tree&` if `flag=0`. If `flag=1` then the item is displayed in normal video. If you have used the `MENU` function to display the menu bar then the `tree&` is the value returned by the function call. The `title` number is calculated as described under the `MENU` function and is also returned in the message packet following a `MN_SELECTED` event.

```
SUB menu_text(BYVAL tree&, BYVAL item, BYVAL
      text$)
```

Modifies the menu `item` to be `text$` in the menu object tree `tree&` If you have used the `MENU` function to display the menu bar then the `tree&` is the value returned by the function call. The `item` number is calculated as described under the `MENU` function. `text$` must not be larger than the original text string in the object tree when it was created (e.g. with `MENU`). If you need to make the string larger call the `MENU` function again.

GEMAES: Objects

```
FUNCTION objc_add(BYVAL tree&, BYVAL parent,
      BYVAL child)
```

Adds an object with index `child` as a child of the object `parent` in the object tree `tree&`. Returns 0 if there is an error or non-zero if no error occurs.

```
FUNCTION objc_delete(BYVAL tree&, BYVAL
      object)
```

Delete the `object` from the object tree `tree&`. This removes the link from the parent to the `object`. Returns 0 if there is an error or non-zero if no error occurs.

```
FUNCTION objc_draw(BYVAL tree&, BYVAL object,
      BYVAL depth, BYVAL x, BYVAL y, BYVAL w,
      BYVAL h)
```

Draws part or all of the object tree `tree&` starting with `object` and drawing to a depth of `depth` using a clipping rectangle starting at (x,y) of width `w` and height `h`. If `depth=0` then only the starting object is drawn; if `depth=1` then the first generation children of the object are drawn and so on. Returns 0 if there is an error or non-zero if no error occurs.

```
FUNCTION objc_find(BYVAL tree&, BYVAL object,
      BYVAL depth, BYVAL x, BYVAL y)
```

Returns the object number of the item in the object tree `tree&` which contains the point (x,y). The search starts at `object` and is to a depth of `depth` as specified in `objc_draw`. If the point is not under any object then -1 is returned.


```
FUNCTION objc_offset(BYVAL tree&, BYVAL
      object, x, y)
```

Returns in (x,y) the co-ordinates of `object` from the tree `tree&` relative to the screen. Returns 0 if there is an error or non-zero if no error occurs.

```
FUNCTION objc_order(BYVAL tree&, BYVAL object,
      BYVAL newpos)
```

Moves `object` in the tree `tree&` to a different position in its parents list of children. If `newpos` is

-1	moved to the front of the list
0	moved to the end of the list
1	moved to 1 from the end
2	moved to 2 from the end etc.

This function returns 0 if there is an error or non-zero if no error occurs.

```
FUNCTION objc_edit(BYVAL tree&, BYVAL object,
      BYVAL char, BYVAL index, BYVAL kind,
      newindex)
```

Performs the low level editing of the `object` in tree `tree&`. The object must be of type `G_TEXT` or `G_BDXTEXT`. The operation performed depends on the value of `kind`:

1	`ED_INIT`	combine the strings from the `te_ptext` and `te_ptmplt` fields of the `TEDINFO` structure into a formatted string and display it with the text cursor on.
2	`ED_CHAR`	validate the character `char`, which was probably typed by the user, against `te_pvalid` and update `te_ptext` and re-display the string. The original index in the string to use is `index` and the updated value is stored in `newindex`.
3	`ED_END`	Removes the text cursor.

The function returns 0 if there is no error or non-zero if an error occurs.

```
FUNCTION objc_change(BYVAL tree&, BYVAL
      object, BYVAL x, BYVAL y, BYVAL w, BYVAL
      h, BYVAL newstate, BYVAL flag)
```

Modifies the `ob_state` field of the `object` in tree `tree&` to be `newstate` and if `flag=1` redraws the object with a clip rectangle at (x,y) with width `w` and height `h`.If `flag=0` then the `ob_state` is modified but the object is not re-drawn.

The function returns 0 if there is no error or non-zero if an error occurs.

GEMAES: Forms

```
FUNCTION form_do(BYVAL tree&, BYVAL object)
```

lets the user fill in a form given by the object tree `tree&` with the interaction starting with object number `object`. `object` must be an editable text field or 0 if the form does not contain any editable text fields. The value returned is the index of the object that caused the exit (e.g. an OK button).

```
SUB form_dial(BYVAL flag, BYVAL x1, BYVAL y1,
      BYVAL w1, BYVAL h1, BYVAL x2, BYVAL y2,
      BYVAL w2, BYVAL h2)
```

The function performed depends on the value of `flag`

0	FMD_START	does not actually do anything on current versions of the operating system, but should be called before making a series of `form_dial` calls.
1	FMD_GROW	draws a box expanding from the rectangle given by (x1,y1,w1,h1) to that given by (x2,y2,w2,h2). This is similar to `graf_growbox`.
2	FMD_SHRINK	draws a box shrinking from (x2,y2,w2,h2) to (x1,y1,w1,h1) This is similar to `graf_shrinkbox`.
3	FMD_FINISH	sends messages to re-draw the screen for any windows inside the rectangle given by (x2,y2,w2,h2).

```
FUNCTION form_alert(BYVAL default, BYVAL
      alert$)
```

Displays an alert on the screen an lets the user interact with it. The default button is given by the `default` parameter and is 1 for the first button, 2 for the second etc and 0 if there is no default button. The value returned is the number of the button selected. The screen is restored by the AES; there is no need to re-draw the screen.`alert$` has the form:

`[icon][message[button1|button2.....]`

`icon` is the number of the icon to display:

0	no icon
1	! icon
2	? icon
3	STOP icon.

`message` is the text to display in the alert box; it should not exceed 200 characters and should contain | (vertical bar) characters to delimit the lines. `button1` and `button2` are the text for the buttons. There may be up to three buttons; the text for each can not exceed 20 characters.

If the `text$` parameter does not conform to the above rules the machine may crash.

```
FUNCTION form_error(BYVAL errorcode)
```

This displays the error message box corresponding to the GEMDOS `errorcode` parameter unless this is greater than 63 when the call is ignored. The value returned is the button that was clicked on. This is always 1 on current versions of the operating system.

```
SUB form_center(BYVAL tree&, x, y, w, h)
```

This routine returns the co-ordinates (x,y) and width `w` and height `h` of a dialog box object tree `tree&` that are needed to centre the object on the screen ready for use in `form_dial` etc. The tree itself is also modified.

GEMAES: Graphics

```
SUB graf_rubberbox(BYVAL x, BYVAL y, BYVAL
      minw, BYVAL minh, outw, outh)
```

Lets the user drag a rubber box starting at (x,y) with a minimum width and height of `minw` and `minh`. The current width and height when the user lets go of the mouse button are returned in `outw` and `outh`.

```
SUB graf_dragbox(BYVAL w, BYVAL h, BYVAL
      startx, BYVAL starty, BYVAL boxx, BYVAL
      boxy, BYVAL boxw, BYVAL boxh, outx,
      outy)
```

lets the user drag a box of fixed size (w,h) starting at `startx,starty` returning the final position in `outx` and `outy`. (The box will always be contained within the rectangle specified by `boxx, boxy, boxw` and `boxh`).

```
SUB graf_movebox(BYVAL w, BYVAL h, BYVAL x1,
      BYVAL y1, BYVAL x2, BYVAL y2)
```

draws a box of width `w` and height `h` moving from (x1,y1) to (x2,y2).

```
SUB graf_growbox(BYVAL x1, BYVAL y1, BYVAL w1,
      BYVAL h1, BYVAL x2, BYVAL y2, BYVAL w2,
      BYVAL h2)
```

draws a box outline expanding from the rectangle given by `x1, y1, w1, h1` to that given by `x2, y2, w2, h2`.

```
SUB graf_shrinkbox(BYVAL x1, BYVAL y1, BYVAL
      w1, BYVAL h1, BYVAL x2, BYVAL y2, BYVAL
      w2, BYVAL h2)
```

draws a box outline shrinking from the rectangle given by `x2, y2, w2, h2` to that given by `x1, y1, w1, h1`. Note that in both `graf_growbox` and `graf_shrinkbox` the larger rectangle is second.

```
FUNCTION graf_watchbox(BYVAL tree&, BYVAL
      object, BYVAL instate, BYVAL outstate)
```

changes a box while the user moves it in and out of the box specified by `object` in the tree `tree&`. The mouse button *must* be down when this routine is called and it returns 0 if the mouse is outside the box when the user releases the button and 1 if it is inside. `instate` and `outstate` give the box's `ob_state` field when the pointer is inside and outside of the box respectively.

```
FUNCTION graf_slidebox(BYVAL tree&, BYVAL
      parent, BYVAL object, BYVAL vertical)
```

Lets the user move the box given by the `object` from the tree `tree&` within its parent box given by `parent`. If `vertical=1` then the movement is vertical; if `vertical=0` then it is horizontal. The value returned gives the position of the inner box when the user releases the mouse button and ranges from 0 to 1000 with 0 being top or left depending on the value of `vertical`. The mouse button *must* be down when this routine is called.

```
FUNCTION graf_handle(wcell, hcell, wbox, hbox)
```

returns the current GEM VDI handle that the AES is using and the width and height of the character cells of the system font in pixels in `wcell` and `hcell`; together with the size of a box large enough to enclose a character in this font in `wbox` and `hbox`.


```
SUB graf_mouse(BYVAL flag, BYVAL user_form&)
```

This call changes the mouse form that is displayed according to the value in flag as described in the following table:

0	arrow
1	text cursor (vertical bar)
2	busy bee
3	pointing finger
4	extended fingers
5	thin cross hair
6	thick cross hair
7	outline cross hair
255	user defined mouse form given by the buffer pointed to by `user_form&`
256	hide mouse
257	show mouse

The hide and show the mouse calls above have the disadvantage that, if the `wind_update` calls are not used correctly, then the machine may crash or loose the ability to use menus. The `v_hide_c` and `v_show_c` GEM VDI calls do not suffer from this problem; however we have experienced the AES missing mouse clicks after certain combinations of these calls.

```
SUB graf_mkstate(x, y, state, kstate)
```

returns the current mouse position in (x,y), the current mouse button state and the state of the Shift , Alt and Ctrl keys . In `state` bit 0 is the left button and bit 1 is the right button. A value of 0 means the button is up and 1 means the button is down. `kstate` bits are as follows:

Mask	*Key*
1	right Shift
2	left Shift
4	Ctrl
8	Alt

As usual a bit is 0 if the key is up and 1 if the key is down.

GEMAES: Scrap Directory

```
FUNCTION scrp_read(directory_name$)
```

Reads the current scrap directory into the string variable parameter `directory_name$` and returns 0 if an error occurred. Returns non-zero if no error occurred.

FUNCTION scrp_write(BYVAL directory_name$)

Sets the current scrap directory to the string parameter `directory_name$` and returns 0 if an error occurred. Returns non-zero if no error occurred.

GEMAES: File Selector

SUB fsel_input(path$, name$, ok)

Displays and lets the user use the standard GEM AES file selector. The initial and updated values of the drive and path are passed in `path$` and the initial and final file name are passed in `name$`. `name$` should be a maximum of 12 characters long. `ok` is returned as 0 if the user clicked on `Cancel` and 1 otherwise. If an error occurs `ok` is returned as 0 and the strings are not updated.

SUB fsel_exinput(path$, name$, ok, BYVAL prompt$)

This displays and lets the user interact with the extended GEM file selector, whilst displaying a message to indicate the action about to be taken (e.g. `Save File`).

The parameters of this call are the same as for fsel_input except for the extra `prompt$` parameter. This string (which may be up to 30 characters long) is displayed instead of the `Item Selector` message.

This operating system call was added in Rainbow TOS (AES version 1.30).

GEMAES: Windows

FUNCTION wind_create(BYVAL kind, BYVAL x, BYVAL y, BYVAL w, BYVAL h)

Creates a window with a maximum size given by the rectangle of width `w` and height `h` with top left `(x,y)` and returns the window's handle as the result of the function or a negative value if no windows are available.

`kind` specifies the components present in the window with the following bit masks for the individual components:

1	NAME	title bar with name
2	CLOSE	close box
4	FULL	full box
8	MOVE	can be moved
16	INFO	information line below title
32	SIZE	size box
64	UPARROW	upwards arrow
128	DNARROW	down arrow
256	VSLIDE	vertical slider
512	LFARROW	left arrow
1024	RTARROW	right arrow
2048	HSLIDE	horizontal slider

This call does *not* display the window; use `wind_open` (see below) to do this. It is *imperative* that the window is deleted before your program exits using `wind_delete` otherwise the window will not be deleted until you return to the Desktop; if you do this too often you will find that the system runs out of windows. We strongly recommend that yon use the `WINDOW` commands built into HiSoft BASIC as these will always be closed and deleted as long as the program does not finish with a 68000 exception (bombs).

FUNCTION wind_open(BYVAL handle, BYVAL x, BYVAL y BYVAL w, BYVAL h)

Displays the window with the given `handle` with an initial position of `(x,y)` and width `w` and height `h`. The co-ordinates include the window's border. The window handle is obtained from the `wind_create` call (see above). This routine returns 0 if there was an error ; 1 otherwise.

FUNCTION wind_close(BYVAL handle)

Closes the window with the given `handle`. This means that the window is not displayed but may be displayed again using `wind_open`. To delete a window you must close it and then call `wind_delete` (see below). This routine returns 0 if there was an error ; 1 otherwise.

FUNCTION wind_delete(BYVAL handle)

Deletes the window with the given `handle`. This means that the memory allocated to the window and the window handle are freed. If the window is displayed you *must* close it using `wind_close` (see above) first. This routine returns 0 if there was an error ; 1 otherwise.

FUNCTION wind_get(BYVAL handle, BYVAL sort, x, y, w, h)

This call returns information about the window handle depending on the value of sort. This routine returns 0 if there was an error ; 1 otherwise.For most values of sort x, y, w and h specify a rectangle as nsual. In the table below the exceptions to this are noted. The names in this table are included in the GEMAES.BH file prefaced with WF_.

Sort	*Name*	*Action*
4	WORKXYWH	the current work area of the window is returned.
5	CURRXYWH	the current size of the window including borders.
6	PREVXYWH	the co-ordinates of the previous window including borders.
7	FULLXYWH	the maximum size of the current window including borders.
8	HSLIDE	x contains the current position of the horizontal slider between 1 and 1000. 1 is the left most position.
9	VSLIDE	x contains the current position of the vertical slider between 1 and 1000. 1 is the top most position.
10	TOP	x contains the handle of the top (active) window.
11	FIRSTXYWH	the co-ordinates of the first rectangle in the window's rectangle list.
12	NEXTXYWH	the co-ordinates of the next rectangle in the window's rectangle list.
15	HSLSIZE	x contains the size of the horizontal slider relative to the horizontal scroll bar (1 to 1000) or -1 if the default square box.
16	VSLSIZE	x contains the size of the vertical slider relative to the vertical scroll bar (1 to 1000) or -1 if the default square box.
17	SCREEN	x and y give the address of the internal to the AES alert buffer and w and h give the length of this buffer. x and w are the most significant words.

FUNCTION wind_set(BYVAL handle, BYVAL sort, BYVAL x, BYVAL y, BYVAL w, BYVAL h)

This call sets the various attributes of the window according to the value of sort. This routine returns 0 if there was an error; 1 otherwise. For most values of sort x, y, w and h specify a rectangle as usual. Exceptions are noted under the particular sort. The following values of sort are the same as for wind_get : CURRXYWH, HSLIDE, VSLIDE, TOP, HSLSIZE, VSLSIZE. In addition the following are available:

Sort	*Name*	*Action*
2	NAME	x, y are the address of the name of the window. x is the most significant word of the address.
3	INFO	x, y are the address of the text in the information line of the window. x is the most significant word of the address.
14	NEWDESK	x, y are the address of an object tree containing the new GEM desktop for the AES to draw. w is the first object to draw in the tree. If x and y are both 0 then the desktop is reset to the default one.

Warning: Be careful when passing strings to the AES using NAME and INFO as above, because these are not copied by the AES and thus if HiSoft BASIC performs a garbage collect the string may move. The solution is to store the string in a numeric array that is dimensioned before any arrays that are REDIMmed or ERASEd.

The following will pass the address stored in the variable x& as two integers:

```
PEEKW(VARPTR(x&)), PEEKW(VARPTR(x&)+2)
```

FUNCTION wind_find(BYVAL x, BYVAL y)

returns the handle of window that is under the co-ordinate (x,y). 0 is returned if there is no window under (x,y).

FUNCTION wind_update(BYVAL sort)

This routine can be used to stop the user using menus, moving windows etc. whilst the application is outputting to the screen or when the application wants to do its own tracking of the mouse. These routines should be called strictly in pairs. If you call END_MCTRL more times than BEG_MCTRL the machine may hang.

The different `sort`s are:

1	BEG_UPDATE	tells the operating system that the application is about to update the window and will wait until menus are not down before doing this. You should call this routine before writing to a window with the VDI.
0	END_UPDATE	tells the operating system that the application has finished updating the window and that the user may pull down menus once more. Should be called after you have called the VDI if you called this routine with BEG_UPDATE.
3	BEG_MCTRL	tells the operating system that the application is performing all mouse control itself and the AES will not let the user pull-down menus or click on windows.
2	END_MCTRL	tells the operating system that the application has finished doing its own mouse control and so the AES will let the user, once more, pull down menus and click on close boxes etc. Must always be called if you have called this routine with BEG_MCTRL beforehand.

This function returns 0 if there was an error ; 1 otherwise.

```
FUNCTION wind_calc(BYVAL type, BYVAL kind,
      BYVAL x, BYVAL y, BYVAL w, BYVAL h,
      xout, yout, wout, hout)
```

Calculates the work area of a window in `xout, yout, wout, hout` given a border of a window in `x, y, w, h` and the sort of window in `kind` if `type=1`. If `type=0` then the border area is calculated given the work area. `kind` is defined under `wind_create`. This routine returns 0 if there was an error ; 1 otherwise.

```
SUB wind_new
```

closes and deletes all windows, flushes all window buffers and returns to standard mouse usage including the `wind_update` count.

This is the function that is used by the Desktop to tidy up after an application quits and so should be used if your application needs to run a possibly badly behaved program. Unfortunately this call is only available on AES version 1.30 (Rainbow TOS) and above, so that it cannot be used by lazy programmers to return to a fixed state!

GEMAES: Resource Files

```
FUNCTION rsrc_load(BYVAL file_name$)
```

Loads the resource file called `file_name$` into memory. The memory is allocated from GEMDOS. Normally only a limited amount of memory is returned to GEMDOS by the BASIC program but you can change this by using the `L` (leave) and `K` (keep) compiler options. See *Appendix B* and *Chapter 3* of the *User Manual*. Resource files are created by resource construction set programs such as HiSoft WERCS. This routine returns 0 if there was an error ; non-zero otherwise.

```
FUNCTION rsrc_free
```

Frees the memory used by `rsrc_load`. This routine returns 0 if there was an error; 1 otherwise.

```
FUNCTION rsrc_gaddr(BYVAL type, BYVAL index,
      addr&)
```

Returns the address of a data structure from the resource file loaded using `rsrc_load` in `addr&`. `index` is the index of the data structure in the object tree (returned by the resource construction set) and `type` gives the type of the object:

0	tree	
1	OBJECT	
2	TEDINFO	
3	ICONBLK	
4	BITBLK	
5	string	
6	image data	
7	ob_spec	
8	te_ptext	
9	te_ptmplt	
10	te_pvalid	
11	ib_pmask	
12	ib_pdata	
13	ib_ptext	
14	bi_pdata	
15	ad_frstr	the address of a pointer to a free string (i.e with INDIRECT set in its ob_flags field).
16	ad_frimg	the address if a pointer to a free image. (i.e with INDIRECT set in its ob_flags field).

```
FUNCTION rsrc_saddr(BYVAL type, BYVAL index,
      BYVAL addr&)
```

Sets up the address of a free string or image given `type` and `index` as for `rsrc_gaddr` to be `addr&`. `type` must be 15 or 16. This routine returns 0 if there was an error ; non-zero otherwise.

```
SUB rsrc_obfix(BYVAL tree&, BYVAL object)
```

converts the `object` in `tree&` location from character co-ordinates to pixel co-ordinates. Character co-ordinates are used in resource files to store the co-ordinates of object so that they do not depend on the physical characteristics of the device, in particular on the ST's screen mode. Normally this conversion is performed automatically by the `rsrc_load` call. Character co-ordinates have the character position in the least significant byte of the word and the positive or negative pixel offset in the most significant byte.

GEMAES: Shell Routines

```
FUNCTION shel_read(cmd$, tail$)
```

returns the file that the application was loaded from in `cmd$` and the command line tail that was used in `tail$`. The command tail is also available from the `COMMAND$` function. This should be called before performing a `rsrc_load` call, because otherwise the name of the resource file will be returned as `cmd$`. This routine returns 0 if there was an error ; non-zero otherwise. If this is used from a program that is being developed interactively `HBASIC.PRG` is the current file.

```
FUNCTION shel_find(file$)
```

searches for the file named `file$` in the current directory and the search path and returns this directory in `file$.file$` is therefore modified by the call. Note that if the file is found in the current directory this does not include the drive specifier. This routine returns 0 if there was an error; non-zero otherwise.

```
SUB shel_get(BYVAL buff&, BYVAL length)
```

reads the AES's internal shell buffer (the RAM version of the DESKTOP.INF file) into the buffer at `buff&`; `length` bytes will be read. The buffer should be at least 4192 bytes long to accommodate for TOS versions later than AES version 1.40 (Rainbow TOS).


```
SUB shel_put(BYVAL buff&, BYVAL length)
```

writes into the AES's internal shell buffer (the RAM version of the DESKTOP.INF file) from the buffer at the given address. `length` bytes will be written. The length must not be greater than 1024 bytes for AES versions prior to 1.40 (Rainbow TOS) or 4192 bytes for later TOS's. If you write a new buffer to the AES, you must place a single Ctrl-Z (26 decimal) to indicate the end of the buffer.

```
FUNCTION shel_write(BYVAL ex, BYVAL gr, BYVAL
      over, BYVAL commandname$, BYVAL
      commandline$)
```

run another program when this application has finished. The `ex` and `over` parameters must be 1 in all current versions of the operating system. The `gr` parameter specifies whether the program to be run is a .TOS (or .TTP) program (use 0 for this parameter) or a GEM (i.e. .PRG or .APP) program.

The `commandname$` parameter specifies the complete filename (including extension) of the program to be run. The `commandline$` parameter specifies the command tail

```
SUB shel_envrn(env$, BYVAL name$)
```

Searches the GEMDOS environment string for a particular variable and returns the result in `env$`. `name$` should include the = sign. Unfortunately with current versions of the operating system there is no easy way to set the variables. However if you use "`PATH=`" this will return a pointer to the current path. This can be modified by the Saved! by HiSoft desk accessory.

Menu Library

```
FUNCTION Menu&(BYVAL menu_string$)
```

This routine creates an object tree containing a menu and displays it. The value returned is the address of the object tree for use in subsequent GEM AES calls.

An example of the format of the string is as follows:

```
menu$= "[  Desk |  About HiSoft BASIC ]"
menu$=menu$+ "[  File |  New \  Load \(----------\  Save
]" menu$=menu$+ "[  Search |  Find ]"
```

Using this string will display a menu that is similar to part of the HiSoft BASIC menu bar. Each menu title and its items are enclosed in square brackets [and]. There is a vertical bar (|) after each menu title and the individual items are separated by back-slashes (\). For grey items precede the text with a single open parenthesis (. The first menu is always the desk title (normally `Desk`); the currently loaded desk accessories will automatically be added by the AES.

We recommend that you precede each menu item with two spaces and have a least one space after the item. Menu titles should have one space before and after them.

The number of each item is calculated as follows. Assuming we have n menu titles including `Desk` then the number of the desk menu title is 3, the first user title 4 ... the last user n+2. The `About..` item is n+5, the first desk accessory (if present) is n+7, the sixth is n+12, and the first item in the first user menu is n+14. The second item is n+15 and so on. Grey items are included in this counting as are the menu titles. So if the last item on one menu is 21 the first on the next menu is 23.

Thus in the example above n=3.

```
Desk      3
File      4
Search    5
```

Items:

About	8	(3+5)
New	17	(3+14)
Load	18	
Save	20	skip one for the grey ------
Find	22	skip one for `Search` title

Obviously when you add or remove an item in a menu these numbers will change. It is therefore best to use the `CONST` construct to give the items readable names. This has the advantage of making your program more readable and it is much easier to change one constant rather than several.

The `About..` message may not be more than 20 characters long (otherwise GEM will print them outside the box of the menu).

The memory for the menu tree is allocated using GEMDOS; subsequent `MENU` calls will free the space currently used. It is possible for the operating system memory to run out; see the options section for how to modify the amount a RAM allocated to this. This function also makes a copy of string on the stack whilst executing.

Menus created with this function will be "removed" when the program terminates.

Chapter 3
HiSoft GEM Toolbox Reference

The *HiSoft GEM Toolbox* (HGT) is a collection of BASIC source code modules that, together, allow you to access the Graphics Environment Manager (GEM) within your programs, quickly and easily.

We provide you with the source code to these routines for two reasons; firstly so that you can use just the parts that you need for your particular application and secondly so that you can appreciate how GEM works.

Normally you will use HGT by `REM $include`ing the code that you need.

For any particular task you will not use all of the HGT modules although it is certain that you will need TOOLBOX.BAS since this contains all the initialisation code for the toolbox together with many of the global variables used. It is therefore a good idea to use a pre-tokenised version of TOOLBOX.BAS to cut down the compilation time; we have provided such a file for you (TOOLBOX.T in the HGT folder).

You can, of course, pre-tokenise any combination of the toolbox routines to speed up your development time. You do this by writing a small BASIC program that `REM $includes` all the toolbox modules that you want to tokenise and then choosing Dump tokens from the Program menu.

We will now discuss each HGT routine in more detail, grouping them by their particular purpose.

> Some routines must be supplied by you and these are marked with a sidebar, like the one alongside this paragraph. You will be told what this routine should do and you can find examples of different user routines in the HGT example programs.

General control routines

The following modules are essential to most HGT programs and are included in the TOOLBOX.BAS file.

SUB StartProgram(resourcefile$, BYVAL treenumber, BYVAL exititem)

This sub-program should be invoked at the beginning of programs that are to use the toolbox menu, resource file and window facilities. This loads the resource file and uses the menu tree given by `treenumber` as the menu, with `exititem` specifying the Quit item on that menu. This routine also initialises the toolbox's file selector.

If you have a program that uses the window and file selector facilities without a menu, use `""` for the `resourcefile$` string.

If you want to do your own handling of the Quit item, perhaps to request confirmation from the user, you should pass -1 as the exit item. To load a resource file without displaying a menu pass 0 as the `exititem` parameter.

Note that this routine will call `InitResourceFile` and `InitMenuSystem` for you, automatically , if required.

SUB HGTLoop

This procedure is responsible for the main work of the toolkit. It handles and responds to the keyboard, mouse and menus. You should call it after calling `StartProgram` and after your own initialisation code.

In turn, `HGTLOOP` will call your own routines `ProcessClicks`, `Processkeys` and `ProcessUserMenus` for you as appropriate. These sub-programs must be written by you as described below if your program allows mouse, keyboard or menu input respectively. Setting `finished_flag` to -1 within one of these routines will cause `HGTLoop` to be exited.

SUB StopProgram

This should be called when your program terminates; it frees the system resources that you have used within the toolbox.

SUB InitResourceFile(name$)

Loads the resource file with the given name. If the resource file can't be loaded (or there is too little free GEMDOS RAM to load it) an alert is displayed and the program quits. This is normally called for you by `StartProgram`.

SUB BusyBee(BYVAL Busy)

If `Busy` is true (non-zero) then the mouse is displayed as a 'busy bee'; if it is 0 then it is displayed as an arrow.

DECLARE SUB ProcessClicks(BYVAL clicks, BYVAL kstate, BYVAL x, BYVAL y)

This sub-program should be supplied by you if you want to process mouse clicks yourself. If you set the `clicks_enabled` global variable to a non-zero value before invoking `HGTLOOP`, `ProcessClicks` will be called when the user single or double clicks with the mouse. The `clicks` parameter gives the number of clicks (1 or 2), the `kstate` parameter gives the state of the keyboard Shift keys as per `evnt_multi` and the `x` and `y` parameters passes the mouse position when the click was detected.

SUB Debug(BYVAL a$)

`Debug` can be used to display debugging messages on the screen in cases where using `PRINT` either isn't possible because you don't have a window open or will corrupt the standard output from your program. After displaying your message `Debug` waits for you to press a key before continuing in case the message is obscured. This routine uses the BIOS for output so it doesn't look very pretty.

The easiest way to display numeric data with `Debug` is to use one of the `FORMATx$` functions.

SUB AbortProgram(a$)

This procedure displays its argument message using `Debug` and then stops the program using `StopProgram`.

SUB ProcessKeys(BYVAL ascii$, BYVAL scan_code, BYVAL kstate)

This routine should be supplied by you if you wish to process key presses yourself (i.e. not merely menu keyboard shortcuts). Setting the global variable `keys_enabled` to a non-zero value will cause `ProcessKeys` to be called. This routine is *not* called if a menu keyboard shortcut is used.

The `ascii$` parameter gives the ASCII value of the character that has been selected. While this is suitable for ordinary characters and control sequences, in order to detect Alt combinations, function keys and special keys you will need to use the `scan_code` parameter. If you want to detect the state of the Shift keys directly, use the `kstate` parameter.

Object Handling routines

The following object handling routines are part of the main toolbox, not least because they are used by the other parts of the toolbox. They are therefore in TOOLBOX.BAS.

You need to understand about the tree structure of a resource file before these routines are of much use to you. Read the *WERCS* chapters and, particular, the *Tree Structure* sections under *Programming with Resources* in *Chapter 4* where the concepts used below are explained.

SUB SelectTreeAddr(BYVAL t&)

Selects a new tree given the address of the root.

SUB SelectTree(BYVAL treeno)

Selects a new tree given the tree number from the resource file. You must have loaded a resource file using `StartProgram` or `InitResourceFile` to call this routine and you should use the constants in the .BH file that is created by WERCS.

FUNCTION ObjectAddr&(BYVAL object)

Returns the address of the `object` in the current tree. `object` is the index as given by WERCS (0, 1, ...). This function is published for completeness - you should not need to use it since all the subsequent functions need the object *number* rather than its address within the tree.

FUNCTION Getob_head(BYVAL object)

Returns the value of the `ob_head` field in the given `object` of the currently selected tree.

FUNCTION Getob_tail(BYVAL object)

Returns the value of the `ob_tail` field in the given `object` of the current tree.

FUNCTION Getob_spec&(BYVAL object)

Returns the value of the `ob_spec` field in the given `object` of the current tree.

FUNCTION Getob_state(BYVAL object)

Returns the value of the `ob_state` field in the given `object` of the current tree.

FUNCTION Getob_flags(BYVAL object)

Returns the value of the `ob_flags` field in the given `object` of the current tree.

FUNCTION Getob_type(BYVAL object)

Returns the value of the `ob_type` field in the given `object` of the current tree.

FUNCTION Getob_next(BYVAL object)

Returns the value of the `ob_next` field in the given `object` of the current tree.

FUNCTION Getob_x(BYVAL object)

Returns the value of the `ob_x` field in the given `object` of the current tree.

FUNCTION Getob_y(BYVAL object)

Returns the value of the `ob_y` field in the given `object` of the current tree.

FUNCTION Getob_width(BYVAL object)

Returns the value of the `ob_width` field in the given `object` of the current tree.

FUNCTION Getob_height(BYVAL object)

Returns the value of the `ob_height` field in the given `object` of the current tree.

SUB Setob_state(BYVAL object, BYVAL value)

Sets the value of the `ob_state` field in the given `object` of the current tree.

SUB Setob_flags(BYVAL object, BYVAL value)

Sets the value of the `ob_flags` field in the given `object` of the current tree.

SUB Setob_x(BYVAL object, BYVAL value)

Sets the value of the `ob_x` field in the given `object` of the current tree.

SUB Setob_y(BYVAL object, BYVAL value)

Sets the value of the `ob_y` field in the given `object` of the current tree.

SUB Setob_width(BYVAL object, BYVAL value)

Sets the value of the `ob_width` field in the given `object` of the current tree.

SUB Setob_height(BYVAL object, BYVAL value)

Sets the value of the `ob_height` field in the given `object` of the current tree.

```
SUB Exclob_state(BYVAL object, BYVAL
      flag_mask)
```

Removes a mask (e.g. `mask_selected`, `mask_disable`) from the `ob_state` field in the given `object` of the current tree.

```
SUB Inclob_state(BYVAL object, BYVAL
      flag_mask)
```

Includes a mask (e.g. `mask_selected`, `mask_disable`) in the `ob_state` field in the given `object` of the current tree.

```
FUNCTION Curob_state(BYVAL object, BYVAL
      flag_mask)
```

Returns non-zero if the mask (e.g. `mask_selected`, `mask_disable`) from the `ob_state` field is set.

```
SUB Exclob_flags(BYVAL object, BYVAL
      flag_mask)
```

Removes the mask (e.g. `mask_selectable`, `mask_exit`) from the `ob_flags` field in the given `object` of the current tree.

```
SUB Inclob_flags(BYVAL object, BYVAL
      flag_mask)
```

Includes the mask (e.g. `mask_selectable`, `mask_exit`) in the `ob_flags` field in the given `object` of the current tree.

```
FUNCTION Curob_flags(BYVAL object,BYVAL
      flag_mask)
```

Returns non-zero if a mask (e.g. `mask_selectable`, `mask_exit`) from the `ob_flags` field is in the given `object` of the current tree.

```
SUB Sette_ptext(BYVAL object, BYVAL newted$)
```

Sets the string data in the tedinfo record of the given `object` to be `newted$`. Useful for changing the values that will be displayed in FText and FBoxText objects prior to calling `HandleDialog`.

```
FUNCTION Gette_ptext$(BYVAL object)
```

Returns the current value of the text field of the Tedinto record of the given `object`. Useful for reading the values entered in FText and FBoxText objects prior to calling HandleDialog.


```
FUNCTION Getob_spec$(BYVAL object)
```

Returns the string pointer to be the `ob_spec` field of the `object` as a BASIC string. Useful for String, Text and BoxText objects.

Menu routines

These routines are part of the MENU.BAS file.

```
SUB InitMenuSystem(BYVAL treenumber, BYVAL
      exititem)
```

`InitMenuSystem` displays the menu given by `treenumber` from the resource file and scans that menu for any keyboard short cuts. The parameter `exititem` should be the object number of the item to be used to terminate the program; pass -1 as the `exititem` if you wish to handle the exit item yourself. You shouldn't normally need to call this routine directly as it is called by `StartProgram`.

When designing your menu using WERCS, the ⇧ symbol (character 1) should be used to indicate Shift keyboard shortcuts, the ^ symbol for Ctrl shortcuts and ◆ (character 7) for Alt shortcuts. You may only use one of these modifiers per key.and this modifier can be applied to any ASCII characters on the keyboard.

Menu keyboard short cuts can also be F1, F2, ... F10 and their Shift variants or one of the following special keys:

BS (for Backspace)	Clr	Esc
Help	Home	Ins (for Insert)
Tab	Undo	

```
DECLARE SUB ProcessUserMenus(BYVAL wind,
      BYVAL item, BYVAL title)
```

This routine must be supplied by you if you have a menu and then call the toolbox `HGTloop` sub-program. It is called when the user selects a menu item.

The `wind` parameter is the AES handle of the top window so you can tell which of your windows the user currently has selected. The `item` parameter gives the object number of the item selected (as given by WERCS) and the `title` gives the object number of the title of this menu.

This routine is also called if the user selects one of the shortcuts from the menu, just as if they had actually used the mouse.

Note that, when the exit item that was passed to `InitMenuSystem/StartProgram` is called, `HGTloop` will return without `ProcessUserMenus` being called.

Dialogs and Alerts

The following routines are in the DIALOG.BAS file. With the exception of the alert routines, the tree must have been selected using `SelectTree` or `SelectTreeAddr` before you use these sub-programs.

```
FUNCTION Newform_alert(BYVAL num, BYVAL
      button)
```

```
FUNCTION Newform_alertaddr(BYVAL button, BYVAL
      addr&)
```

These are additional GEM calls that are required to use C-type strings (as loaded from resource files) for alerts. The `Newform_alert` routine takes the Alert's index from the resource file (as provided in the .BH file by WERCS) whereas the `Newform_alertaddr` routine takes the actual address of the string.

```
FUNCTION HandleDialog(BYVAL editnum)
```

A general routine to display a dialog box and handle interaction. The return result is the exit object number. The `editnum` parameter gives the text field where the cursor will be positioned initially; if you don't have any text fields then pass the value 0.

`HandleDialog` centres the form and draws appropriate growing and shrinking boxes for you. It also de-selects the form's exit button.

```
SUB SetTedNumber(BYVAL object, BYVAL value#)
```

Sets a tedinfo field to a numeric value. This is the equivalent to `Sette_ptext` for strings. The format used is the same as would be used if the value were printed as a double. For more control use the `FORMATx$` functions and `Sette_ptext`.

```
FUNCTION GetTedNumber#(BYVAL object)
```

Returns a numeric value from a tedinfo field. This is the equivalent to `Gette_ptext$` for strings.

```
SUB SetButton(BYVAL parent, BYVAL button)
```

Selects a particular radio button in a group, de-selecting all others in that group. The `parent` parameter gives the box containing the radio buttons while the `button` parameter gives the object to be selected; this is the object number within the tree.


```
FUNCTION GetButton(BYVAL parent)
```

Returns which button of a group of radio buttons is selected.

Other object routines

This collection of routines is designed for people who are manipulating object trees directly in memory and the routines are contained in OTHOBJEC.BAS. You will need to be familiar with the structure of object trees before using them. As with the more basic routines, the tree to use must have been selected using `SelectTree` or `SelectTreeAddr`.

```
FUNCTION GetParent(BYVAL index)
```

Returns the object number of this object's parent or -1 if it is the root.

```
SUB ForEachChild(BYVAL parent, BYVAL procadr&)
```

`ForEachChild` is a powerful sub-program that lets you write other procedures to manipulate object trees yourself. `ForEachChild` handles the tree walking for you and you just need to write the sub-program that is executed for each child. Often this can be just a single line as with many of the commands that follow.

The procedure that is called should be parameterless and should be passed to `ForEachChild` using the `VARTPRS` function. The sub-program is called for each child of the object `parent` according to the tree structure.

The sub-program can read the following, globally-shared, variables:

`current`	the object number in the tree of the current object.
`ithchild`	0 for the first child, 1 for the second etc.
`stop_now`	setting this to a non-zero value will stop any other children being considered.

```
FUNCTION HowManyChildren(BYVAL item)
```

Returns the number of children that the given object has.

```
FUNCTION WhichChild(BYVAL item)
```

Returns which child of its parent tree `item` is, or -1 if `item` has no parent. 0 is returned for the first child, 1 for the second etc.

```
FUNCTION IsChild(BYVAL parent, BYVAL
      PossChild)
```

Returns -1 (true) if `PossChild` is a child of (or the same as) `Parent`.

```
FUNCTION ObjectNumber(BYVAL par, i)
```

Returns the object number in the tree of the `ith` child of the object `par`. As usual 0 is used for the first child, 1 for the second etc.

The Window system

This section describe the core of the toolbox's window system that is supplied in WINDOW.BAS. In general you probably won't need to call most of these directly as the higher level routines, described below under *Object*, *Image* and *Text* windows, will suffice.

In general when you use the toolbox you use AES handle numbers. However, internally, the toolbox has its own window numbers which are not the same as AES window handles or the same as HiSoft BASIC window handles. Most of your routines can just use the AES handle but we provide the ability to convert to/from the other types if you need to access the different window calls or you are writing your own window routines.

```
FUNCTION WhichWindow(BYVAL AEShandle)
```

This function returns the Toolbox window handle corresponding to the AES window parameter that is supplied as a parameter.

```
FUNCTION OpenAWindow(WindowName$, BYVAL
      WindComp, BYVAL procaddr&, BYVAL
      slidermaxaddr&, BYVAL closeproc&)
```

Creates, opens a window and clears it to white with the given name and components and returns the corresponding toolbox window handle. If there was an error a HiSoft BASIC runtime error occurs.

`procaddr&` is a low-level re-draw procedure which is called when an area of the window needs to be re-drawn.

This should use the following global variables:

`commonx`
`commony`
`commonw`
`commonh`
	The rectangle to be re-drawn.

`commonhandle`	The AES handle of the window to be re-drawn.

Before the re-draw routine is called, the window will be cleared to white.

`slidermaxproc&` is the address of a sub-program to return the current maximum values for the window's sliders. The global variables that are set up before this routine is called are:

`commonhandle`	The AES handle of the window to be re-drawn.
`commoni`	The index within the window system's internal tables (as returned by `WhichWindow`).

The `slidermax` sub-program should return the maximum possible size of the scrollable area in pixels in the following variables:

`commonmaxx`	The maximum slider value in the x-direction.
`commonmaxy`	The maximum slider value in the y-direction.

The `CloseProc&` parameter of `OpenAWindow` gives the address of the sub-program that is called just before the window is closed. This routine is passed the index of the current window in the window system's internal tables in `commoni`. This close routine is normally used to adjust any internal tables that are particular to a given window type.

The window components are as specified for the HiSoft BASIC `WINDOW OPEN` statement and for the AES `wind_create` call

```
SUB CloseAWindow(WindowHandle)
```

Close a window of the given AES handle. Note that this is passed a variable parameter which will be set to 0 on exit. This means that you can use the window's handle to detect whether that particular window is open or not.

```
FUNCTION IsMyWindow(BYVAL WindowHandle)
```

Returns true (-1) if `WindowHandle` was opened using one of the Toolbox routines that open a window.

```
SUB RenameWindow(BYVAL WindowHandle,
      WindowName$)
```

This subprogram changes the title of the window whose AES handle is `WindowHandle` to be `WindowName$`.

```
SUB InitWindowSystem
```

This initialises the window system. It sets up the internal variables used by the window routines in the toolbox. Normally this will be called the first time that you invoke a routine that opens a window.

Object Windows

These functions are in the OBJWIND.BAS file. This requires the WINDOW.BAS file to be included first.

```
FUNCTION OpenObjectWindowAddr(WindowName$,
      BYVAL WindComp, BYVAL treeaddr&)
```

```
FUNCTION OpenObjectWindow(WindowName$, BYVAL
      WindComp, BYVAL treeno)
```

These routines open a window and associate an object tree with that window that will be re-drawn automatically and can be re-sized and scrolled by the user. This gives an easy way to design control panel windows. To update the information to be displayed you can use the object family functions described above.

Both of these routines require the name and components of the window when creating a window. The `OpenObjectWindow` function is passed the tree number within the current resource file whereas the `OpenObjectWindowAddr` function is passed the address of the tree in memory.

Image window routine

This routine is in the IMAGWIND.BAS file and requires both the WINDOW.BAS and IMAGE.BAS files to be included first.

```
FUNCTION OpenImageWindow(WindowName$,
      WindComp)
```

Opens a scrolling window that displays an image - the image information is taken from the `images()` array. `ImageWindows` is the index within this array. The `images()` array and the actual image data will usually have been set up using

```
LoadPicture filename$,ImageWindows
```

See `LoadPicture` below for details of the types of images that may be loaded.

Text windows

The following routines are in the TEXTWIND.BAS file which requires the WINDOW.BAS file.


```
SUB InitTextWindows (BYVAL MaxFiles, BYVAL
      MaxLines)
```

This sets up the internal variables that are particular to text windows and dimensions the global arrays `lines$()` and `wolines()`.

The first of these arrays is where the actual text of windows is stored; `lines$(0,0)` is the first line of the first text window, `lines$(0,1)` is the second line of the first text window, `lines$(0,2)` is the third line of the first text window and so on. `lines$(1,0)` gives the first line of the second text window.

The maximum line number to display for the first text window is given by `wolines(0)`, that for the second window in `wolines(1)` etc.

The `MaxFiles` parameter gives the maximum number of text windows that you may have open at once and `MaxLines` gives the maximum number of lines that may be displayed for each file.

The `lines$` and `wolines()` arrays require `MaxFiles*(MaxLines*8+2)` bytes of storage not including the actual text of the strings, so don't pass huge numbers to `InitTextWindows`.

`InitTextWindows` also sets the following variables, that can be modified by the user, to the values shown:

`aligntext`	-1
`tabsize`	8
`MaxTextWidth`	300

```
FUNCTION OpenTextWindow(WindowName$, BYVAL
      WindComp)
```

Opens a scrolling window that displays text - the text is stored as lines in the `lines$(i,n)` array where `i+1` is the text file number. The number of lines of text to display is read from `wolines(i)`. You must call `InitTextWindows` before using this routine.

The variable `TextWindows` gives the index in the `lines$()` array. Thus you typically use `TextWindows` to get a window number, set up the corresponding entries in `lines$()` and `wolines()` and call `OpenTextWindow`.

To change the text displayed you modify these arrays directly. Note that closing a text window will cause the index in the arrays for text windows opened after this one to decrease by one. The variables used are:

aligntext	If this is non-zero then text windows will be set up so that the text is displayed on 8 pixel boundaries. This gives a much faster text display and is selected by default.
expandtabsflags tabsize	If expandtabsflag is non-zero then any Tab characters in the text are expanded on screen to the next tabsize boundary. Disabling this will give a slightly faster display. Expansion of tabs to 8 characters is selected by default.
MaxTextWidth	This is the value that the full width of the horizontal slider represents. It is 300 by default.

SUB LoadTextFile(name$, BYVAL index, lines)

This sub-program loads the file called `name$` into `lines$(index)`. The first line line goes into `lines$(index,0)` the second into `lines$(index,1)` etc. The total number of lines read is then placed in `lines`. This is ideal for loading and displaying a text file in a window since all you need is:

```
LoadTextFile name$,textWindows,wolines(TextWindows)
texthandle=OpenTextWindow(name$,win_all-win_info)
```

SUB ExpandTabs(sce$,dest$)

This sub-program expands any tabs in the string `sce$` and writes the expanded text to `dest$`.

The tab size is specified by the global variable `tabsize`.

User Desktop routines

These routines are in the file NEWDESK.BAS.

SUB SetDeskAddr(BYVAL newdesk&)

This sub-program sets the desktop pattern to be a particular object tree whose address is given by `newdesk&`. `SetDeskAddr` also ensures that the desktop is redrawn to show this change. To remove any custom desktop pass 0 as a parameter to this sub-program.

SUB SetDesk(BYVAL treeno)

`SetDesk` lets you specify the desktop to be used by giving a tree number from your resource file. There's no need to set up the co-ordinates of the root object, `SetDesk` will do this for you automatically. To remove your custom desktop use a `treeno` value of -1.

File Selector Routines

These routines are in the FILESEL.BAS file.

FUNCTION FileSelect$

This routine provides a 'quick-and-easy' interface to the GEM Item Selector - it simply returns the pathname that the user selected, so that you can use the file without any further processing. If the user selected Cancel a null string is returned.

The default path and file names are retained from call to call but if you wish to set these directly you can modify the global variables `fspath$` and `fsname$`. You might wish to use a separate path when loading and saving the preferences file of your program or when requesting a particular type of file.

If the `fspath$` variable is null when `FileSelect` is called then `InitFileSelector` is called. Thus, in practice, the path used is the current directory when `FileSelect$` is first called and there's no need to call `InitFileSelector` directly.

SUB InitFileSelector

This initialises the file selector path used by `FileSelect$` to be all files in the current directory and for there to be no default file.

Running other programs

The following routines are in the EXEC.BAS include file.

FUNCTION GetWholeEnvironment$

This function returns the entire environment string of the current program so that it can be passed on to a child process, by the `Execute` sub-program for example.

SUB Execute(nname$,commline$)

`Execute` executes the command called `nname$` with a command line of `commline$`. It is 'polite' in that it removes any menu bar that the program has displayed and closes any windows that the program has created. It then re-displays the menu bar and windows when the child process terminates.

Note that this function does not delete any current open windows. Therefore, if you run a child process when you already have a number of windows open, the child won't have many windows available for its use. Also this function does not search the GEMDOS PATH environment variable or the AES path to find the child program.

Image routines

These routines are in the IMAGE.BAS file.

SUB LoadPicture(finame$, BYVAL index)

This routine loads a GEM (.IMG), Degas (.PI1, .PI2, .PI3, .PC1, .PC2, .PC3) or Neochrome (.NEO) format picture file into RAM so that it can be subsequently displayed by the `DisplayImage` and `OpenImageWindow` routines.

The `images(index...)` will contain a GEMVDI MFDB structure that is used by the display routines, while the actual image data is loaded into memory that is allocated from GEMDOS memory.

You should ensure that the file that you are loading exists; if an image file is malformed or there is insufficient memory to load the image then the program will abort with a suitable message.

SUB DisplayImage(BYVAL index, BYVAL x, BYVAL y)

This routine displays an image that has been loading using `LoadPicture(filename$,index)` at screen co-ordinates (x,y). If you want to write your own custom image display routines, perhaps to display just a portion of an image, you can base them on this routine.

SUB CloseImage(BYVAL index)

This frees the memory that was used by the image specified by `index`..

SUB CloseAllImages

`CloseAllImages` frees the memory that was used by all the images that wereloaded via `LoadPicture`.

Desk Accessories

The file ACCTBOX.BAS is the equivalent of the main TOOLBOX.BAS but will let you write desk accessories.

Note that the caveats mentioned in the *Desk Accessory* appendix concerning memory management and screen resolution changes apply equally to the toolbox. ACCTBOX.BAS has exactly the same facilities as TOOLBOX.BAS except:

`StartProgram`, `StopProgram`, `ProcessClicks`, `ProcessKeys`, and all the menu facilities are not present but are replaced by:

SUB StartAccessory(daname$)

This is the equivalent to `StartProgram` and is passed the text to appear in the Desk menu for this desk accessory.

SUB AccOpened

This is the routine that you must write which is called every time the desk accessory item for this DA is selected; the window system will already be initialised ready for use when this is called although you will need to call `InitTextWindows` if you are using `TextWindows`.

The variable `AlreadyOpen` is set to -1 if the desk accessory has a window open.

Chapter 4
WERCS Reference

This chapter contains detailed information on programming with resource files, compiling the WERCS example program and the file formats used by WERCS.

This section of the manual is designed to help you when programming with resource files that have been created by WERCS. The first section describes the objects and their attributes, whilst the second considers the programming aspects of these data structures. It concludes by discussing the WERCS' specific file formats.

Objects

There are thirteen different types of objects as follows:

Box

A Box is a rectangle whose interior colour and fill pattern is controllable, as is its border thickness.

BoxChor

A BoxChar is a graphic box containing a single text character. It also has colour and border size attributes.

BoxText

Similar to Text objects (see later) but in addition surrounded by a border whose size and colour can be specified.

Button

A Button is displayed as a centred string of characters with a border. If the *default* flag is set, pressing the Return key in the standard form-handler is the same as clicking on the Button. A Default button is shown with a wider border. A new Button created with WERCS has its Selectable and Exit flags set.

FBoxText

An FBoxText object is a formatted BoxText object; in addition to the normal Text attributes, it also has border attributes, a template and two extra strings for text entry. These extra strings are called the Template and Valid fields. The AES displays the Template string as if it were displaying any other type of text except that for every underline character it displays a character from the main text string. For example, a date field object might consist of a Text entry of:

```
011088
```

and a Template of

```
Date:__/__/__
```

this would be displayed as

```
Date:01/10/88
```

if it were an FBoxText.

Remember: underline characters are entered as tildes (~).

The Valid string is used when the object is used as a Form using the GEM `form_do` command. The Valid string specifies which characters may be typed for each underline character in the Template string.

The diffcrent validation characters are:

X	all characters allowed
9	Only 0-9
A	A-Z and space
a	A-Z, a-z, 128-255 and space
N	A-Z, 0-9 and space
n	A-Z, a-z, 0-9, 128-255 and space
P	A-Z, a-z, 0-9, 128-255, \ : ? * . _
p	A-Z, a-z, 0-9, 128-255, \ : _
F	A-Z, a-z, 0-9, 128-255, : ? * _
f	A-Z, a-z, 0-9, 128-255, _

In the above A-Z includes non-English capital letters. 128-255 means that all characters greater with value greater than 128 can be used, including lower case non-English letters and the £ sign.

You can use different validation characters in the same string if you wish. Thus for the date example above we would use the 9 character for all 6 character positions since the only characters allowed in dates are digits.

The most commonly used of these validation digits are probably X and 9. Note that if you wish to enter negative numbers you have to use X (otherwise the - sign would not be allowed).

Also the pathname options (P and p) are of limited value as a number of software producers sadly use illegal pathname characters such as - in their filenames. All but the X, F and f validation characters also have the undesirable feature with the first, 1.0, operating system ROMs of crashing the system when you press _!

Note that whilst validation characters, P, p, F and f allow you to enter lower case letters these are echoed as the upper case equivalents.

If otherwise illegal characters are present in the Template string then the AES will skip past them if they are entered. With our date example typing / will skip to the next field even though / is not otherwise a valid character.

You should ensure that there are at least as many underlines in the Template string as there are characters in the main Text string; otherwise all of the latter will not be displayed. If you are intending to use this object as a Form *in situ* as normal, you should have the same number of characters in the Text string as there are underlines in the Template; if you don't observe this then if the user types a long string, the next string from your resource file will be corrupted. This restriction does not apply if you are intending to change the address of the Text field when the resource file is loaded.

So, in general, ensure that there are exactly the same number of characters in your Text string as there are underlines in your Template string.

Surprisingly, the Valid string does not have to contain a character for every underline in the Template string; if all the validation characters are the same then you can use just one. We have not seen this officially documented but it certainly works on all versions of the operating system we have used and can lead to considerably reduced resource file and memory usage if you have long strings.

If the first character in a text field is the at-sign (@), then `form_do` will display your string as underlines and place the cursor at the start of the string. Thus you can enter a blank string of n characters by typing, say ~, n-1 times, press cursor left until you are at the start of the string and then press @. The string will then disappear; but don't worry; it will be stored in your file ready for use.

FText

Similar to a FBoxText (see above) but without border attributes.

IBox

An IBox is a so-called *invisible box*, similar to a Box but hollow. It is only truly invisible if its border has a thickness of zero.

Icon

This consists of two bit-map images, one for data and one for a mask. In addition a string of characters and a single character are also associated with it. Icons also have their own foreground and background colours.

Image

An Image is a graphic bit-map with a foreground colour attribute. It differs considerably from an Icon; it has no mask (so cannot be distinguished on a patterned background), and no associated text or single character.

PragDef

This type of object is for advanced assembly language programmers only. It allows you to create your own types of object by supplying your own drawing routines. ProgDefs are displayed in WERCS as boxes with a diagonal line. ProgDefs are also known as *UserDefs*. We have seen the latter term used mainly in older documentation; a hangover perhaps from days when a Digital Research *user* was someone who wrote the assembly language to install CP/M on their computer.

String

A String is a sequence of characters drawn in black and in the standard system font. If you require different sized or coloured text you should use one of the formatted text object types.

Text

Actually graphic text; this is a sequence of characters that can be displayed in the system font or in a small font and can be left-, centre- or right-justified.

Title

Objects of type Title are only used as Menu titles. Their use in other types of tree is not recommended; they have the same attributes as Strings.

Flag Types

The different flag types for objects are as follows:

Selectable

The Selectable flag is used in conjunction with the `form_do` AES routine. If this flag is set then if the user clicks on the object during a `form_do` call it will be highlighted and the Selected state bit will be set. If the Selected bit was already set, the object will be shown as normal and the Selected bit reset.

Thus setting this bit effectively turns any object into a Button without changing the appearance of the object. All Buttons that are to be used as such should have this bit set; this is the default when you create a new Button with WERCS.

Default

The Default bit tells the AES that this is the default button of the form, i.e. the one which will be returned if the user types Return.

Normally this is used for Buttons but can also be used for other types. With Buttons the Default bit causes the object to be displayed with a wider border so that the user can see the default. For other objects there is no change in the screen display.

If the Default bit is set for an object you should normally also set the Selectable and Exit bits.

We do not recommend having more than one Default item in a form; the user, your program and the AES are likely to get confused.

Exit

The Exit bit is used to indicate that clicking on this object will cause form_do to return to your program, with the index of this object as its result. If the Exit bit is not set the user can continue to edit the Form.

This bit can be used for any type of object, but only with Buttons is the size of the border increased to indicate to the user that this is an Exit Button. When you create a new Button using the Object menu this bit will be set.

The Selected bit should be set whenever the Exit bit is set.

Editoble

The Editable bit should only be set for the FText and FBoxText objects; this indicates that the user may edit the text in this field. If you set this bit for other types of objects the AES will mis-behave often causing the system to bomb. The fields in the TEDINFO structure used by the AES for FText and FBoxText objects must conform to strict rules as described under FBoxText.

There is no need to set other flags in conjunction with the Editable flag.

Do not use an Editable text field as the *last* object in a Form; all the current versions of the operating system will crash if you press cursor down when editing this field.

Radio Button

The Radio Button bit is used to indicate that an object is one of a set of radio buttons. The objects need not be of type Button.

Every sibling of the object should have the Radio Button bit set; to ensure this you can use an IBox to surround just the objects that you wish to be Radio Buttons. Radio Button objects should have the Selectable flag set.

For an example of programming with Radio Buttons see the WTEST program.

Touch Exit

The Touch Exit bit is used to tell the AES to exit `form_do` when the user moves the mouse pointer over an item and clicks on it. The exit occurs when the mouse button is pressed down (rather than released as in the case of the Exit flag). Touch Exit also differs from Exit in that the button need not be Selectable. When using `form_do`, if the user double-clicks on a Touch Exit object then the top bit of the return value will be set. Even if your program is not interested in double-clicks, you still need to mask off the top bit.

This flag may be used with any kind of object.

Hide

The Hide bit is used to hide an object and all its children from the AES. This means that the object is not displayed by `objc_draw` and will not be found by `objc_find`. This is useful when you wish to remove part of a tree temporarily, without re-organising that tree. For example, WERCS itself uses this facility when drawing the Extras dialog box to ensure that only appropriate types of objects are shown.

If you have hidden an object using WERCS you cannot use the Hide command from the Flags menu to unhide it again because you cannot select it; instead select its parent and then use the UnHide Children command from the same menu instead.

Flag States

The flag states for objects are as follows.

Selected

If the Selected flag is set, it indicates that the object will be displayed highlighted. This bit is changed from 0 to 1 or from 1 to 0 if the object is Selectable when the user clicks on the appropriate object. Any type of object may have this bit set.

Crossed

The Crossed bit causes the AES to draw a white diagonal cross through the object. If the object is Selected then the cross is displayed as black. This flag can be used on all objects except IBoxes.

Checked

If the checked flag is set the AES will draw the object with a black tick mark, ✓, inside it with the tick in the top left corner. When the object is Selected the tick is shown in Black. The Checked flag may be used for any type of object including IBoxes.

Disabled

If the Disabled flag is set for an object then it is shown greyed, that is, with less intense colour than normal. In addition, Disabled objects may not be Selected when using `form_do` or as part of a Menu even if they have the Selectable bit set. Note, though, that Disabled Editable fields may be edited!

Outlined

If the Outlined bit is set then the object is drawn with a black box outside it. Note that this does not form part of the object as far as `objc_find`, for example, is concerned. This bit may be used with all types of objects.

Shadowed

If the Shadowed bit is set for an object a shadow is drawn outside the object in the object's border colour; this includes Buttons. The Shadowed bit has no effect on objects without a border.

Selecting both Outlined and Shadowed attributes produces a messy display of the object and should be avoided.

Object, Flags and States Summary

The following table shows which attributes change the appearance on screen for each type of object. Text Attr refers to the alignment and size of text:

	Fill Pattern	*Fill Colour*	*Xparent/ Opaque*	*Border Colour*	*Border Size*	*Text Colour*	*Text Attr*
Box	✓	✓		✓	✓		
BoxChar	✓	✓		✓	✓	✓	
BoxText	✓	✓	✓	✓	✓	✓	✓
Button							
FBoxText	✓	✓	✓	✓	✓	✓	✓
FText			✓		✓	✓	✓
IBox				✓	✓		
Icon		✓				✓	
Image						✓	
ProgDef							
String							
Text			✓		✓	✓	✓
Title							

The following table shows the effect of particular flag/state sets for a number of the Flags. Remember that Selectable, Radio Button, TouchExit, Selected and Outlined may be used for all types of objects except Titles:

	Default	*Exit*	*Editable*	*Crossed*	*Disabled*	*Shadowed*
Box	☞	☞	*	✓	☞	✓
BoxChar	☞	☞	*	✓	✓	✓
BoxText	☞	☞	*	✓	✓	✓
Button	✓	✓	*	✓	✓	✓
FBoxText	☞	☞	☞	✓	✓	✓
FText	☞	☞	☞	✓	✓	✖
IBox	☞	☞	*	✖	☞	✓
Icon	☞	☞	*	✓	✓	✖
Image	☞	☞	*	✓	✓	✖
ProgDef	☞	☞	*	✓	✓	✖
String	☞	☞	*	✓	✓	✖
Text	☞	☞	*	✓	✓	✖
Title	☞	☞	*	✓	✓	✖

Key:

✓	Changes appearance of object and the behaviour of the AES.
☞	Changes the behaviour of the AES but not the appearance.
✖	Has no effect.
*	Causes the machine to crash with bombs.

Programming with Resources

This section details the various data structures and object types, together with common AES programming algorithms. This section uses the standard names and offsets for the data structures and their components which are supplied in the header file gemaes.bh. It also describes the low-level functions used by the HiSoft GEM Toolbox for accessing these structures.

Tree Structure

OBJECT Structure

A tree is stored in memory as an array of objects. Each object has pointers to allow the AES to tree-walk as required. The structure is as follows:

ob_next	word*	index of object's next sibling
ob_head	word*	index of first child or -1 if none
ob_tail	word*	index of last child or -1 if none
ob_type	word*	object type (high byte is ignored by the AES and used for extended object numbers)
ob_flags	word†	
ob_state	word†	
ob_spec	longword*	depends on object type
ob_x	word†	X co-ordinate of object relative to parent (in pixels)
ob_y	word†	Y co-ordinate of object relative to parent (in pixels)
ob_width	word†	width of the object in pixels
ob_height	word†	height of the object in pixels

All the fields are present for all objects although the ob_spec field depends on the object type and is usually a pointer to another structure as described below.

Those items marked with † may be read and set using HGT routines of the form Getob_xxxc and Setob_xxx and those with a * may be read using Getob_xxxx. You must be sure to select the appropriate tree first via SelectTree or SelectTreeAddr. For example to read the type of the root object (object 0) of the current tree, you would use:

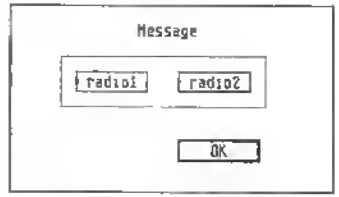
```
typ=Getob_type(0)
```


Similarly, to set the width of object 4 to be 32 pixels, you could use

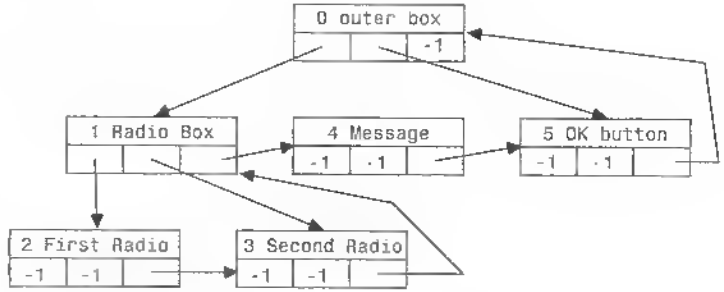
```
Setob_width 4,32
```

In a real program you would use the identifier from the .BH file created by WERCS rather than 4 itself.

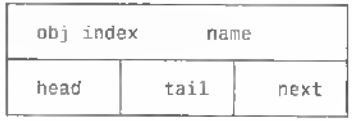
When it is loaded into memory an object tree is like an array of records. The first object (with index 0) is called the *root object*. It is normally the outer Box of a dialog box. Each object in the tree has three fields called ob_head, ob_tail and ob_next. These hold integer values that dictate to the AES the structure of the tree. Fortunately you do not normally need to access these directly, WERCS does it for you. As an example, say we have a dialog box like this:



The tree structure this represents can be shown as:



where each box represents:



When this is stored in memory the index and first three fields of the various objects will be:

Index	*ob_head*	*ob_tail*	*ob_next*	*name*
0	1	5	-1	outer box
1	2	3	4	Radio Box
2	-1	-1	3	First Radio
3	-1	-1	1	Second Radio
4	-1	-1	5	Message
5	-1	-1	0	OK button

Object number 0 is called the *root* of the tree. Its *children* are Message, Radio Box and OK button. Radio box's *parent* is outer box; its children are First Radio and Second Radio; its *siblings* are Message and OK button. First Radio and Second Radio are *childless* and they are *grand children* of the root object, outer box.

Normally what is important with object trees is the tree structure not the order that the items are in memory. For example, don't assume that the first child immediately follows its parent.

We can now give concise definitions of the ob_head, ob_tail and ob_next fields:

ob_head	points to the first child (or is -1 if childless)
ob_tail	points to the last child (or is -1 if childless)
ob_next	points to the next sibling or, if there are no more siblings, to the object's parent.

Values for the ob_type field, together with the interpretation of the ob_spec field will now be described, followed by the definition of the data structures to which they refer.

Box G_BOX; 20

The ob_spec field contains the colour word (low word) and border thickness (high word).

Text G_TEXT 21

The ob_spec field contains a pointer to a TEDINFO structure; the te_ptext pointer within the structure points to the actual displayed text.

BoxText G_BOXTEXT 22

The ob_spec field contains a pointer to a TEDINFO structure; the te_ptext pointer within the structure points to the actual displayed text.

Image G_IMAGE 23

The ob_spec field contains a pointer to a BITBLT structure.

ProgDef G_PROGDEF 24

The ob_spec field contains a pointer to an APPLBLK structure.

IBox G_IBOX 25

The ob_spec field contains a colour word (low word, only border colour attribute used) and border thickness (high word).

Button G_BUTTON 26

The ob_spec field contains a pointer to the displayed string.

BoxChar G_BOXCHAR 27

The ob_spec field is used for the following fields:

bits 24-31	ASCII value of displayed character
bits 16-23	border size
bits 0-15	colour word

String G_STRING 28

The ob_spec field contains a pointer to the displayed string.

FText G_FTEXT 29

The ob_spec field contains a pointer to a TEDINFO structure. The text pointed to by te_ptext is merged with the template pointed to by te_ptmplt before display. The fill attributes in te_color are ignored.

FBoxText G_FBOXTEXT 30

The ob_spec field contains a pointer to a TEDINFO structure. The text pointed to by te_ptext is merged with the template pointed to by te_ptmplt before display.

Icon G_ICON 31

The ob_spec field contains a pointer to an ICONBLK structure.

Title G_TITLE 32

The ob_spec field contains a pointer to the displayed string.

Object Flags

The various flags in the ob_flags field have the following values as bits and as a hexadecimal mask:

Name on Menu	*Standard Name*	*Bit*	*Mask*
Selectable	SELECTABLE	0	1
Default	DEFAULT	1	2
Exit	EXIT	2	4
Editable	EDITABLE	3	8
Radio Button	RBUTTON	4	16
	LASTOB	5	32
Touch Exit	TOUCHEXIT	6	64
Hide	HIDETREE	7	128
	INDIRECT	8	256

The LASTOB bit is used by the AES to find the last object in an object tree; it is sel for the last object and the last object alone. This bit is handled by WERCS for you but you may find it useful to access it if you write routines to manipulate trees in memory.

If the INDIRECT bit is set, the ob_spec field is treated as a *pointer* to the ob_spec field rather than the value itself. WERCS does not allow you to set this bit; if you need it then your program should set it and re-initialise the ob_spec field as required.

The GEMAES.BH defines these items as masks, pre-facing them with mask_ and the HGT defines the following functions to manipulate these:

Curob_flags returns non zero if a given bit is set in an object and zero if it is not.

For example, Curob_flags (i,mask_selectable) returns true if the ith object in the current tree has the SELECTABLE bit set.

Inclob_flags set a given bit in an object. For example Inclob_flags i,mask_default sets the default bit for object i.

Exclob_flags resets a given in bit; thus Exclob_flags i, mask_hidetree will 'un-hide' object i.

Object States

The following table gives the values as bits and masks of the ob_state field.

Name on Menu	*Standard Name*	*Bit*	*Mask*
Selected	SELECTED	0	1
Crossed	CROSSED	1	2
Checked	CHECKED	2	4
Disabled	DISABLED	3	8
Outlined	OUTLINED	4	16
Shadowed	SHADOWED	5	32

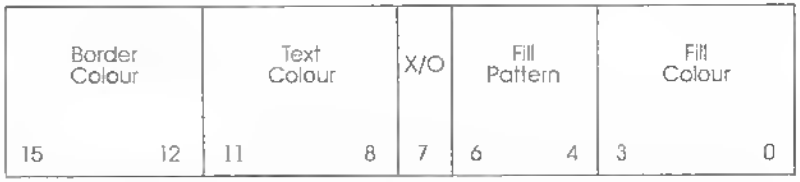
The GEMAES.BH defines these items as masks, pre-facing them with mask_There are HGT routines that are analogous to those for object flags. So Curob_state(i,mask_selected) returns true if the ith object is selected, Inclob_state i,mask_disabled disables object i and Exclob)state

Border Thickness

The low byte of the high word in some ob_spec fields stores the border thickness in pixels. A value of 0 means no border, positive values give a border inside the object, negative values force it outside the object.

Colour Word

The colour word used in some ob_spec fields consists of the following components:



In the above diagram the numbers indicate the bits, so that the Border Colour is in bits 15-12, the four most significant bits of the first byte.

X/O is the Transparent/Opaque bit; Opaque is indicated by the bit being set.

Fill Pattern is as on the Fill menu with 0 indicating hollow- and 7 solid-fill.

The Border, Text and Fill Colours are as on the appropriate menus. The standard names for the colours are:

Colour	Value	Colour	Value
WHITE	0	LWHITE	8
BLACK	1	LBLACK	9
RED	2	LRED	10
GREEN	3	LGREEN	11
BLUE	4	LBLUE	12
CYAN	5	LCYAN	13
YELLOW	6	LYELLOW	14
MAGENTA	7	LMAGENTA	15

The L in the above names indicates *light*. If you *must* encode a colour word into your program the best base to use is hexadecimal.

TEDINFO Structure

This structure is used by the object types BoxText, FBoxText, FText and Text:

te_ptext	longword	pointer to actual text
te_ptmplt	longword	pointer to template; editable portion denoted by underscores
te_pvalid	longword	pointer to string containing validation characters
te_font	word	font used: 3=system font, 5=small font
te_resvd1	word	reserved for future use
te_just	word	text justification required: 0=left, 1=right, 2=centre
te_color	word	object colour and pattern of box-type objects (see previously for word format)
te_resvd2	word	reserved for future use
te_thickness	word	border thickness
te_txtlen	word	length of te_ptext string (*including* null)
te_tmplen	word	length of te_ptmplt string (*including* null)

The HGT defines `Sette_ptext` and `Gette_ptext$` to set and return BASIC strings from/to the `te_ptext` field. For example, `Sette_ptext i,newted$` will set the `te_ptext` field of the `i`th object to be `newted$`. Similarly `Gette_ptext(i)` will return the text field corresponding to the `i`th object.

ICONBLK Structure

This is used by the Icon object type only:

ib_pmask	longword	pointer to icon mask
ib_pdata	longword	pointer to icon data
ib_ptext	longword	pointer to the text displayed with the icon
ib_char	word	low byte is the displayed character, high byte defines colour used - top nibble is foreground colour, bottom nibble is background
ib_xchar	word	X co-ordinate of ib_char relative to ib_xicon
ib_ychar	word	Y co-ordinate of ib_char relative to ib_yicon
ib_xicon	word	X co-ordinate of icon relative to the ob_x of the object
ib_yicon	word	Y co-ordinate of icon relative to the ob_y of the object
ib_wicon	word	width of the icon image in pixels (must be a multiple of 16)
ib_hicon	word	height of icon image in pixels
ib_xtext	word	X co-ordinate of icon's text relative to the ob_x of the object
ib_ytext	word	Y co-ordinate of icon's text relative to the ob_y of the object
ib_wtext	word	width of rectangle to display icon's text in (centred)
ib_htext	word	height of icon's text

The bit images for the mask and data are stored as arrays of words.

BITBLK Structure

This is used by the Image object type and Free Images only:

bi_pdata	longword	pointer to bit image
bi_wb	word	width of Image data in bytes (must be even)
bi_hl	word	height of Image in pixels
bi_x	word	source X co-ordinate
bi_y	word	source Y co-ordinate
bi_color	word	colour word (see previously)

bi_x and bi_y are used as offsets into the bit image given by bi_pdata; any bits before this will be ignored.

APPLBLK Structure

This is used by ProgDefs:

ab_code	longword	pointer to code to draw the object
ab_parm	longword	passed as a parameter to the low-level drawing routine

PARMBLK Structure

This is passed to ProgDef drawing routines:

pb_tree	longword	pointer to start of object tree
pb_obj	word	the object index
pb_prevstate	word	the old state of the object to be changed
pb_currstate	word	the new (changed) state of the object
pb_x, pb_y	words	the pixel X and Y screen co-ordinates of the object
pb_w, pb_h	words	the pixel width and height of the object
pb_xc, pb_yc	words	the pixel X and Y screen co-ordinates of the current clip rectangle
pb_wc, pb_hc	words	the pixel width and height of the current clip rectangle
pb_parm	longword	copied from the address after the pointer to the drawing routine

If pb_prevstate and pb_currstate are the same then the AES is drawing the object, not changing it.

Hints & Tips on Resources

Using ProgDefs

If a loaded resource file contains any ProgDef objects, their ob_spec field will not be initialised on loading - this is up to the programmer. An APPLBLK structure needs to be allocated and initialised, then a pointer to it planted in the relevant ob_spec field.

The drawing routine (planted in the ab_code field) will then be called whenever that object needs drawing or changing. The routine should normally be written in assembly-language, save all registers except D0 and must not call the AES under any circumstances as the AES is *not* re-entrant.

When your custom drawing routine has finished the value it returns is the ob_state value which you wish the AES to render over your object, i.e. returning a value of 0 applies no extra effects, whereas returning CROSSED (for instance) would draw a cross over the object. Note that any number of ob_state values may be ORed together to produce the required effect..

When designing ProgDefs it is often easiest to base them on existing objects which can be manipulated in WERCS, e.g. in the example program we implement a rounded button based on the normal square button, hence the text may be manipulated from within WERCS.

When the AES calls your drawing code you are still in the AES' 'context', i.e. you are using it's stack, hence recursive routines or large local arrays may cause it to overflow.

If you draw using the AES' handle then you should ensure that you maintain any of the VDI attributes, alternatively you may use your own virtual workstation which will avoid these problems.

Creating New Desktops

It is possible to replace the standard GEM background pattern (the area of the screen not used by the menu bar) using a special tree. This allows different colours and fill patterns to be used, as well as allowing icons to appear on the desktop.

A Form should be created in WERCS with the root object being a borderless Box with a suitable fill pattern and colour. If any icons are required these should be added to this Form. The size of the Form is not relevant. To tell GEM to use this Form, the size and position (ob_x, ob_y, ob_width and ob_height) fields in the root object should be set to the usable screen size, found using the AES wind_get(DESK, WF_WORKXYWH, ... call. The form can then be installed using a wind_set(WF_NEWDESK, ... call with an object parameter of zero. Before your program terminates, the desktop must be de-installed by passing a NULL value to the same call.

Note that installing a desktop does not cause it to be drawn and you should normally call form_do(FMD_FINISH, ... to force a redraw of the area.

The HiSoft GEM Toolbox NEWDESK.BAS file shows this in practice.

Common Mistakes and how to avoid them

The following is a list of common mistakes made when programming with GEM and resources in general. The reasons given here are brief as there is insufficient space to expand upon them; they act as pointers for where to look in other documentation.

Problem: My program was mainly working but now it crashes during its initialisation.

Reason: Your resource file is out of step with your program and what was the Menu that you were displaying is now a Form; as a result the GEM menu_bar call bombs. Re-compile all the parts of your program that rely on the header file.

Problem: My dialog box doesn't disappear after you click on OK.

Reason: The dialog box is on top of one of your windows and you are not replying to WM_REDRAW events. If you don't open a window, the Desktop will re-draw the desktop tree for you automatically .

Problem: My program crashes when it should be displaying a Dialog Box.

Reason 1: If you have no editable fields and are passing -1 as the starting object the machine may crash, despite what some documentation says. Use 0 instead.

Reason 2: If you do have editable text fields make sure that they conform to the rules under FBoxText regarding editable text.

Problem: A GEM program crashes unexpectedly. After rebooting, the same program works correctly under the same conditions.

Reason: A program has modified GEM's data structures unintentionally. There are many possible ways of doing this; one to look out for is not doing a v_clsvwk after a v_opnvwk; that is leaving a Virtual Workstation open.

Problem: The mouse disappears or leaves extra pixels on the screen ('mouse droppings').

Reason: Your graf_mouse calls are mis-balanced in some way. For each hide (M_ON) call you *must* have a show (M_OFF) call.

Problem: There are mouse droppings where a menu has been pulled down.

Reason: You are not using wind_update (BEG_UPDATE, ... and graf_mouse (or the VDI v_hide_c) before writing to the screen.

Problem: When using some desk accessories the screen display is messed up.

Reason: Make sure that you are taking note of WM_REDRAW events and only updating the areas given by the wind_get (WF_FIRSTXYWH, ... and wind_get (WF_NEXTXYWH, ... calls. To test this, move a desk accessory about the screen; the Control Panel and the Saved! desk accessory can both be used.

Problem: Some desk accessories 'lose' their mouse when invoked from my program.

Reason: Make sure you don't remove the mouse until *after* you have done a wind_update (BEG_UPDATE, ... call and make sure that it is visible before calling wind_update for END_UPDATE.

Problem: The program works fine in medium and high resolution, but crashes when accessing a menu on 'old' ROM machine.

Reason: Your menu is taking up more than one quarter of the screen. When running in Low Resolution, a menu may not contain more than 16000 pixels. If you are using large menus, you may wish to consider using a special menu for low resolution, as WERCS does.

.BH file details

The .BH file produced by WERCS consists of constant declarations of the form:

```
CONST label%=1
```

If you have a saved a resource file called TEST.RSC you would then include the constants from the name file using:

```
rem $include test.bh
```

The characters allowed in names are:

`A-Z, a-z` as the first character and:

`A-Z, a-z, 0-9, _` and . in subsequent characters.

The WTEST Example Program

To illustrate the most common resource-handling programming requirements, we supply an example program called WTEST.BAS. A ready-to-run version called WTEST.PRG is supplied on the master disks; it needs WRSC.RSC to run.

When compiling the source code version you will need the GEMAES.BH file from your HiSoft BASIC master disk as well as the WRSC.BH file produced by WERCS.

WTEST structure

The program is deliberately over-simplified; it manages to avoid calling the VDI completely and gets away with an evnt_mesag, avoiding the dreaded evnt_multi. The general structure of the code in all the programs is as follows:

Procedure INITIALISE

This does the required GEM initialisation then loads the resource file. The tree address of the menu is found and the menu installed. The usable screen size is found and certain global variables initialised.

Procedure SETDESK

This sets the new desktop pattern to be a particular address and forces the AES to re-draw the whole screen.

Procedure DEINITIALISE

Resets any installed desktop, removes the menu bar, frees the resource, then does any required GEM de-initialisation.

Procedure HANDLE_DIALOG

A general dialog box handler which starts by centring and drawing the box. User interaction is handled by form_do and, on return, if the exit object was a Button, it is de-selected.

Procedure SET_TEDINFO

This allows a particular TEDINFO structure to have its data portion set to a particular string.

Procedure GET_TEDINFO

Allows a particular TEDINFO structure to return its data portion.

Procedure SET_BUTTON

This allows one particular radio Button to be set from a group. If invalid parameters are specified the routine will never finish.

Procedure GET_BUTTON

Allows a group of radio Buttons to be interrogated to see which is selected.

Procedure TEST_DIALOG

This handles the particular dialog box in the resource file. It implements proper cancelling - that is, if it is cancelled, the Button state and Text entry are left alone.

Procedure HANDLE_MENU

This is the menu-click dispatcher; it takes various actions, depending on which menu item has been clicked, and also de-selects the menu title.

Procedure MAIN

This is the main loop, acting only on MN_SELECTED message events. In a proper program evnt_multi would be used and a far greater selection of cases would have to be dealt with.

Chapter 5
MonSTB Reference

This is the reference manual for the debugger that is supplied with HiSoft BASIC. Note that on the TT you must use MonTTB.

For details on how to use the debugger with BASIC programs, please refer to *Chapter 3* of the *User Manual*.

Numeric Expressions

MonSTB has a full expression evaluator, based on that in the DevpacST assembler, GenST, including operator precedence.

The following operators are supported, in decreasing order of precedence:

monadic minus (-) and plus (+), address of line number (#)

bitwise not (~)

shift left (<<) and shift right (>>)

bitwise And (&), Or (!) and Xor (^)

multiply (*) and divide (/)

addition (+) and subtraction (-)

equality (=), less than (<), greater than (>), not equals (<> or !=), less than or equal (<=), greater than or equal (>=)

The comparison operators are signed and return 0 if false or -1 ($FFFFFFFF) if true. The shift operators take the left hand operand and shift it the number of bits specified in the right hand operand, vacated bits are filled with zeroes.

This precedence can be overridden by the use of parentheses (and). With operators of equal precedence, expressions are evaluated from left-to-right. Spaces in expressions (other than those within quotes - ASCII constants) are not allowed.

All expression evaluation is done using 32-bit signed-integer arithmetic, with no checking of overflow.

The MonSTB expression evaluator also supports indirection using the { and } symbols. Indirection may be performed on a byte, word or long basis, by following the } with a period then the required size, which defaults to long. If the pointer is invalid, either because the memory is unreadable or not an even address (if word or longword indirection is used) then the expression will not be valid.

For example, the expression

```
{data_start+10}.w
```

will return the word contents of location `data_start+10`, assuming `data_start` is even. Indirection may be nested in a similar way to ordinary parentheses.

Numbers

Absolute numbers may be in various forms:

decimal constants, e.g. `\1029`

hexadecimal constants, e.g. `12f` or `$12f`

octal constants, e.g. `@730`

binary constants, e.g. `%1100010`

character constants, e.g. `'X'`

\ is used to denote decimal numbers, $ is used to denote hexadecimal numbers (the default), % for binary numbers, @ for octal numbers and single ' or double " quotes for character constants.

Character Constants

Whichever quote is used to mark the start of a string must also be used to denote its end and quotes themselves may be used in strings delimited with the same quote character by having it occur twice. Character constants can be up to 4 characters in length and evaluate to right-justified longs with null-padding if required. For example, here are some character constants and their ASCII and hex values:

`"0"`	`0`	`$00000051`
`'hi'`	`hi`	`$00006869`
`"Test"`	`test`	`$54657374`
`"it's"`	`it's`	`$6974277C`
`'it''s'`	`it's`	`$6974277C`

Symbols and Registers

Symbols may be referred to and are normally case-sensitive and significant to either 8 or 22 characters (depending on the form of debug information used), though this can be changed.

Registers may be referred to simply by name, such as A3 or D7 (case insensitive), but this clashes with hex numbers. To obtain such hex numbers precede them with either a leading zero or a $ sign. A7 refers to the *user* stack pointer.

There are several reserved symbols which are case insensitive, namely TEXT, DATA, BSS, END, SP, SR, and SSP. END refers to one byte past the end of the BSS section and SP refers to either the user- or supervisor-stack, depending on the current value of the status register. Remember that the names of all your external variables and functions will also be available.

In addition you can access the SFC, DFC, CACR, CAAR, VBR, MSP, ISP, MMUSR, TT0, TT1, TC, FPCR, FPSR, and FPIAR registers.

Note that the CRP, SRP cannot be used in expressions since they are 64 bits long.

In addition there are 10 memories numbered M0 through M9, which are treated in a similar way to registers and can be assigned to using the Register Set command. Memories 2 through 5 inclusive refer to the current start address of the relevant window and modifying them will change the start address of that window.

Window Types

There are four window types and the exact contents of these windows and how they are displayed is detailed below. The allowed types of windows are shown in the table below.

Window	*Allowed Types*
1	Register
2	Disassembly
3	Memory
4	Disassembly, Memory or Source code
5	Memory

Register Window Display

The data registers are shown in hex, together with the ASCII display of their low byte and then a hex display of the eight bytes they point to in memory. The address registers are also shown in hex, together with a hex display of 12 bytes. As with all hex displays in MonSTB this is word-aligned, with non-readable memory displayed as **.

The status register is shown in hex and in flag form, additionally with U or S denoting user- or supervisor-modes. A7' denotes the supervisor stack pointer, displayed in a similar way to the other address registers.

The PC value is shown together with a disassembly of the current instruction. Where this involves one or more effective addresses these are shown in hex, together with a suitably-sized display of the memory they point to.

For example, the display

```
TST.W $12A(A3) ;00001FAE 0F01
```

signifies that the value of $12A plus register A3 is $1FAE, and that the word memory pointed to by this is $0F01. A more complex example is the display

```
MOVE.W $12A(A3),-(SP) ;00001FAF 0F01 ⇒0002AC08 FFFF
```

The source addressing mode is as before but the destination address is $2AC08, presently containing $FFFF. Note that this display is always of a suitable size and when pre-decrement addressing is used this is included in the address calculations.

No hex data is shown for the data registers and the address register data area is reduced to 4 bytes. In addition the disassembly line may not be long enough to display complex addressing modes such as the second example above.

The floating point registers (if displayed) are shown first in internal hexadecimal format (omitting the reserved 0 word to save screen space) and in decimal scientific notation. Infinities and NANs (not a number) are shown appropriately. Note that the decimal value shown does not give the full accuracy expressible in extended format; however the hexadecimal value is precise - you should also note that the trignometric facilities of the maths co-processors are only accurate to double rather than extended precision.

Disassembly Window Display

Disassembly windows display memory as disassembled instructions. On the left the hex address is shown, followed by any symbol, then the disassembly itself. The current value of the PC is denoted with ⇒.

If the instruction has a breakpoint placed on it this is shown using square brackets ([ ]) afterwards, the contents of which depend on the type of breakpoint. For stop breakpoints this will be the number of times left for this instruction to execute, for conditional breakpoints this will be a ? followed by the beginning of the conditional expression, for count breakpoints this will be an = sign followed by the current count, and for permanent breakpoints an * is shown.

The exact format of the disassembled op-codes is Motorola standard, as accepted by the assembler, OSM. All output is upper-case (except lower-case labels) and all numeric output is hex, except trap numbers. Leading zeroes are suppressed and the $ hex delimiter is not shown on numbers less than 10. Where relevant numerics are shown signed. The only deviation from Motorola standard is the register lists shown in MOVEM instructions - in order to save display space the type of the second register in a range is abbreviated, for example

```
MOVEM.L d0-d3/a0-a2,-(sp)
```

will be disassembled as

```
MOVEM.L d0-3/a0-2,-(sp)
```

Any displayed symbols replace the hex address display, limited to a maximum of 8 characters.

Memory Window Display

Memory windows display memory in the form of a hex address, word-aligned hex display and ASCII. Unreadable memory locations are denoted by **. The number of bytes shown is calculated from the window width, up to a maximum of 16 bytes per line.

Source-code Window Display

The source-code window displays ASCII files in a similar way to a screen editor. The default tab setting is 8 though this can be toggled to 4 with the *Edit Window* command.

Window Commands

The Alt key is generally used for controlling windows, and when used applies to the *current window*. This is denoted by having an inverse title and can be changed by pressing Tab, or Alt and the window number.

Most window commands work in any window, zoomed or not, though when it does not make sense to do something the command is ignored.

Alt-A Set Address

This sets the starting address of a memory or disassembly window.

Alt-B Set Breakpoint

Allows the setting of any type of breakpoint, described later under *Breakpoints*.

Alt-E Edit Window

On a memory window this lets you edit memory in hex or ASCII. Hex editing can be accomplished using keys 1-9, A-F, together with the cursor keys. Pressing Tab switches between hex & ASCII, ASCII editing takes each keypress and writes it to memory. The cursor keys can be used to move about memory. To leave edit mode press the Esc key.

On a register window this is the same as Alt-R, *Register Set*, described shortly.

On a source-code window this toggles the tab setting between 4 and 8.

Alt-F Font size

This changes the font size in a window. In high resolution 16 and 8 pixel high fonts are used, in colour 8 and 6 pixel high fonts are used. This allows a greater number of lines to be displayed, assuming your monitor can cope.

Changing the font size on the register window causes the position of windows 2 and 3 to be re-calculated to fill the available space.

Alt-L Lock Window

This allows disassembly and memory windows to be locked to a particular register. After any exception the start address of the window is re-calculated, according to the locked register.

To unlock a window simply enter a blank string.

By default window 2 is locked to the PC. You can lock windows to each other by specifying a lock to a memory window, such as M2.

Alt-O Show Other

This prompts for an expression and displays it in hex, decimal and as a symbol if relevant.

Alt-P Printer Dump

Dumps the current window contents onto the printer. The print can be aborted by pressing Esc.

Alt-R Register Set

Allows any register to be set to a value, by specifying the register, an equals sign, then its new value. It can also be used to set the values of the MonSTB memories M0 to M9. For example the line

```
a3=a2+4
```

sets register A3 to be A2 plus 4. You can also use this to set the start address of windows when in zoom mode so that on exit from zoom mode the relevant window starts at the required address.

This command may be used to set all the 68030 and 68881 control registers, so use it with care! The standard floating point registers (FP0-FP7) must be followed by a floating point constant either in decimal or hexadecimal using the same rules as for GenTT. Hexadecimal floating point numbers should be prefixed with either $ or ! and must use the full 12 byte extended format complete with unused second word of 0000.

This command may be used to set the 64-bit CRP and SRP registers; these must be assigned a single 16 digit hexadecimal number without any lead-in character..

Alt-S Split windows

This either splits window 2 into window 2 and window 4, or splits window 3 into window 3 and window 5. Each new window is independent from its creator. Pressing Alt-S again will unsplit the window.

This command has no effect.

Alt-T Change Type

This only works on window 4 (created either by splitting window 2 or by loading a source file). It changes the type of the window between disassembly, memory and source-code (if a file has been loaded).

In TT medium resolution this command may also be used on window 1 (the register window) to toggle the display of the extra 68030 and maths co-processor registers if the smaller font size has been selected.

Alt-Z Zoom Window

This zooms the current window to be full size. Other Alt commands are still available and normal size can be achieved by pressing Esc or Alt-Z again.

Zooming the register window can be extremely useful as it allows you to see the 'hidden' registers M0, M1 and M6-M9.

Cursor Keys

The cursor keys can be used on the current window, and their action depends on the window type.

On a memory window all four cursor keys change the current address, and Shift ↑ and Shift ↓ move a page in either direction.

On a disassembly window ↑ and ↓ change the start address on an instruction basis, ← and → change the address on a word basis.

On a source-code window ↑ and ↓ change the display on a line basis, and Shift ↑ and Shift ↓ on a page basis.

Screen Switching

MonSTB uses its own screen display and drivers to prevent interference with a program's own screen output. To prevent flicker caused by excessive screen switching when single-stepping the screen display is only switched to the program's after 20 milliseconds, producing a flicker-free display while in the debugger. In addition the debugger display can have a different screen resolution to your program's if using a colour monitor.

V View Other Screen

This flips the screen to that of the programs, any key returns to the MonSTB display.

Ctrl-O Other Screen Mode

This changes the screen mode of MonST's display between low and medium resolution. It re-initialises window font sizes and window positions to that of the initial display. This will not effect the screen mode of the program being debugged.

This command is ignored on a monochrome monitor.

This cycles the screen mode of MonTT's display between the five different screen modes available on the TT when using a colour monitor.

As MonSTB has its own idea of where the screen is, what mode it is in and what palette to use you can use MonSTB to actually look at the screen memory in use by your program, ideal for low-level graphics programs.

If your program changes screen position or resolution, via the XBIOS or the hardware registers, it is important that you temporarily disable screen switching using Preferences while executing such code; otherwise MonSTB will not notice the new attributes of your program's screen.

When a disk is accessed, when loading or saving, the screen display will probably switch to the program's during the operation. This is in case a disk error occurs, such as a write-protection violation or a read error, as it allows any GEM alert boxes to be seen and acted upon.

Breaking into Programs

Shift-Alt-Help Interrupt Program

While a program is running it can be interrupted by pressing this key combination, which will cause a trace exception at the current value of the PC. With computationally intensive program sections this will be within the program itself but with a program making extensive use of the ROM, such as the GEMDOS or AES, the interruption will normally be in the ROM itself, or the line-F handler stored in low-memory. If this is the case it is recommended that a breakpoint be placed in your actual program area then a Return to Program command (Ctrl-R) issued.

Pressing Alt-Help without the Shift key will normally produce a screen dump to the printer - if you press this accidentally it should be pressed again to cancel the dump.

It is possible for this key combination to be ignored when pressed - if this occurs press it again and it should work. Pressing it when in MonSTB itself will produce no effect.

A program should never be terminated (using Ctrl-C) if it has just been interrupted in the middle of a ROM routine. This is likely to cause a system crash.

Breakpoints

Breakpoints allow you to stop the execution of your program at specified points within it. MonSTB allows up to eight simultaneous breakpoints, each of which may be one of five types. When a breakpoint is hit MonSTB is entered and then decides whether or not to halt execution of your program, entering the front panel display, or continue; this decision is based on the type of the breakpoint and the state of your program's variables.

Simple Breakpoints

These are one-off breakpoints which, when executed, are cleared and cause MonSTB to be entered.

Stop Breakpoints

These are breakpoints that cause program execution to stop after a particular instruction has been executed a certain number of times. In fact a simple breakpoint is really a stop breakpoint with a count of one.

Count Breakpoints

Merely counters; each time such a breakpoint is reached a counter associated with it is incremented, and the program will resume.

Permanent Breakpoints

These are similar to simple breakpoints except that they are never cleared - every time execution reaches a permanent breakpoint MonSTB will be entered.

Conditional Breakpoints

The most powerful type of breakpoint which allow program execution to stop at a particular address only if an arbitrarily complex set of conditions apply. Each conditional breakpoint has associated with it an expression (conforming to the rules already described). Every time the breakpoint is reached this expression is evaluated, and if it is non-zero (i.e. true) then the program will be stopped, otherwise it will resume.

Alt-B Set Breakpoint

This is a window command allowing the setting or clearing of breakpoints at any time. The line entered should be one of the following forms, depending on the type of breakpoint required:

```
' <address>
```

will set a simple breakpoint.

```
<address>,<expression>
```

will set a stop breakpoint at the given address, after it has executed <expression> times.

```
<address>,=
```

will set a count breakpoint. The initial value of the count will be zero.

```
<address>,*
```

will set a permanent breakpoint.

```
<address>,?<expression>
```

will set a conditional breakpoint, using the given expression.

```
<address>,-
```

will clear any breakpoint at the given address.

Breakpoints cannot be set on addresses which are odd or unreadable, or in ROM, though ROM breakpoints may be emulated using the Run Until command.

Every time a breakpoint is reached, regardless of whether the program is interrupted or resumed, the program state is remembered in the History buffer, described later.

Help Show Help and Breakpoints

This displays the text, data and BSS segment addresses and lengths, together with every current breakpoint. Alt-commands are available within this display.

Ctrl-B Set Breakpoint

This sets a simple breakpoint at the start address of the current window, so long as it is a disassembly window. If a breakpoint is already there then it will be cleared.

U Go Until

This prompts for an address, at which a simple breakpoint will be placed then program execution resumed.

Ctrl-K Kill Breakpoints

This clears all set breakpoints.

Ctrl-A Set Breakpoint then Execute

A command that places a simple breakpoint at the instruction *after* that at the PC and resumes execution from the PC. This is particularly useful for DBF-type loops if you don't want to go through the loop, but just want to see the result after the loop is over.

Ctrl-D GEMDOS Breakpoint

This allows a breakpoint to be set on specific GEMDOS calls. The required GEMDOS number should be entered, or a blank line entered if any existing GEMDOS breakpoint needs to be cleared.

History

MonSTB has a *history buffer* in which the machine status is remembered for later investigation.

The most common way of entering data into the history buffer is by using you single-step but, in addition, every breakpoint reached and every exception caused enters the machine state into the buffer. Various forms of the Run command also cause entries to be made into this buffer.

The history buffer has room for five entries - when it fills up, the oldest entry is removed to make room for the newest entry.

H Show History Buffer

This opens a large window displaying the contents of the history buffer. All register values are shown including the PC as well as a disassembly of the next instruction to be executed.

If a disassembly in the History display includes an instruction which has a breakpoint placed on it the D Js will show the *current* values for that breakpoint, not the values at the time of the entry into the history buffer.

Quitting MonSTB

Ctrl-C Terminate

This will issue a terminate trap to the *current* GEMDOS task. If a program has been loaded from within MonSTB it will be terminated and the message Program Terminated appear in the lower window. Another program can then be loaded, if required.

If no program has been loaded into MonSTB it will itself terminate when this command is used

Terminating some GEM programs prematurely, before they have closed workstations or restored window control properly can seriously confuse the AES and VDI. This may not be noticeable immediately but often causes crashes when a subsequent program is executed.

Loading & Saving

Ctrl-L Load Executable Program

This will prompt for an executable filename then a command line and will attempt to load the file ready for execution. If MonSTB has already loaded a program it is not possible to load another until the former has terminated.

The file to be loaded must be an executable file - attempting to load a non-executable file will normally result in TOS error 66 and further attempts to load executable files will normally fail as GEMDOS does not de-allocate the memory it allocated before trying to load the errant file. If this occurs terminate MonSTB, re-execute it and use the Load Binary File command.

B Load Binary File

This will prompt for a filename and optional load address (separated by a comma) and will then load the file where specified. If no load address is given, memory will be allocated from GEMDOS and used. M0 will be set to the start address and M1 to the end address.

S Save Binary File

This will prompt for a filename, a start address and an (inclusive) end address. To re-save a file recently loaded with the Load Binary File command <filename>,M0, and M1 may be specified, assuming of course that M0 and M1 have not been re-assigned.

A Load ASCII File

This powerful command allows an ASCII file, normally of source code, to be loaded and viewed within MonSTB. Window 4 will be created if required then set up as a source-code window. Memory for the source code is taken from GEMDOS so sufficient free memory must be available. It is recommended that source-code be loaded *before* an executable program to ensure enough memory.

If the file currently being debugged contains HiSoft BASIC debug information, MonSTB will use the line number information corresponding to the new source file that has been loaded. Thus, loading the source file will change the effect of the # operator.

Window 4 is not shown, though an ASCII file may may be loaded in low-res then viewed after switching to medium resolution using Ctrl-O and pressing Alt-S, Alt-T, Alt-T.

If an ASCII file is loaded *after* an executable program the memory used will be owned by the *program itself*, not MonSTB. When such a program terminates, any displayed source-code window will be closed. This is also the case when the source text is automatically loaded by MonSTB.

Executing Programs

Ctrl-R Return to program / Run

This runs the current program with the given register values at full speed and is the normal way to resume execution after entry via a breakpoint.

Ctrl-Z Single-Step

This single-steps the instruction at the PC with the current register values. Single-stepping a TRAP, Line-A or Line-F opcode will, by default, be treated as a single instruction. This can be changed using Preferences.

Ctrl-Y Single-Step

Identical to Ctrl-Z above but included for the convenience of German users.

Ctrl-T Interpret an Instruction (Trace)

This interprets the instruction at the PC using the displayed register values. It is similar to Ctrl-Z but skips *over* BSRs, JSRs, TRAPs, Line-A and Line-F calls, re-entering the debugger on return from them to save stepping all the way through the routine or trap. It works on instructions in ROM or RAM.

Ctrl-S Skip an Instruction

Ctrl-S increments the PC register by the size of the current instruction thus causing it to be skipped. Use this instead of Ctrl-Z when you know that this instruction is going to do something it shouldn't or that you don't like.

R Run (various)

This is a general Run command and prompts for the type of execution, selected by pressing a particular key.

Run G Go

This is identical to Ctrl-R, Run, and resumes the program at full speed.

Run S Slowly

This will run the program at reduced speed, remembering every step in the history buffer.

Run I Instruction

This is similar to Run Slowly but allows a count to be entered, so that a particular number of instructions may be executed before MonSTB is entered.

Run U Until

You will be prompted for an expression which will be evaluated after every instruction. The program will then run, albeit at reduced speed, until the given expression evaluates to non-zero (true) when MonSTB will be entered. For example if single-stepping a DBF loop which used d6 in the ROM code you could say Run Until d6&ffff=ffff (waiting for the low word of d6 to be $FFFF) or, alternatively, PC=FC8B1A, or whatever.

This should not be confused with the Until command, which takes an address, places a breakpoint there then resumes execution.

With all of these commands (except Run Go) you will then be asked Watch Y/N? If Y is selected then the MonSTB display will be shown after every instruction and you can watch registers and memory as they change, or interrupt execution by pressing both Shift keys simultaneously. If N is selected then execution will occur while showing your program's display and execution may be interrupted by pressing Shift-Alt-Help.

Selecting Watch mode with screen switching turned off is likely to result in a great deal of eye strain as the display will be flipped after each and every instruction, particularly alarming with colour monitors.

With any of these Run modes (except Go) all information after every instruction will be remembered in the history buffer. In addition TRAPs will be treated as single-instructions, unless changed with Preferences; though see the warnings under that command about tracing all the way through ROM routines.

When a program is running with one of the above modes a couple of pixels near the top left of the display will flicker, to denote that something is happening, as it is possible to think the machine has hung when, in fact, it is simply taking a while to Run through the code, an instruction at a time.

Searching Memory

G search memory (Get a sequence)

This will prompt Search for B/W/L/T/I?, standing for Bytes, Words, Longs, Text and Instructions.

If you select B, W or L you will then be prompted to enter the sequence of numbers you wish to search for, each separated by commas. MonSTB is not normally fussy about word-alignment when searching, so it can find longs on odd boundaries, for example. If you wish to force a particular alignment, finish the list of items to search for with '¿W'; for word boundaries or '¿L' for longword boundaries.

If you select T you may search for any given text string, for which you will be prompted. You will also be asked whether you wish the search to be case sensitive; if you press Y then Test will match TEST or TeSt

If you select I you can search for part or all of the mnemonic of an instruction; for example if you searched for $14(A you would find an instruction like MOVE.L D2,$14(A0). The case of the string you enter *is* important (unlike MonST version 1), but you should bear in mind the format the disassembler produces, e.g. always use hex numbers, refer to A7 rather than SP and so on.

Once you have selected the search type and parameters, the search begins, control passing to the Next command, described below.

N find next

This can be used after the G command to find subsequent occurrences of the search data. With the B, W, L and T options you will always find at least one occurrence, which will be in the buffer within MonSTB that is used for storing the sequence. With the T option you may also find a copy in the system keyboard buffer. With these options, the Esc key is tested every 64k bytes and can be used to stop the search. With the I option, which is very much slower, the Esc key is tested every 2 bytes.

The search area of memory goes from 0 to the end of RAM, then via the system ROM area and cartridge area then back to 0. MonSTB will not search the cartridge area if the environment variable NOCARTRIDGE exists.

The search will start just past the start address of the current window (except register windows) and, if an occurrence is found, it will re-display the window at the given address.

Searching Source-Code Windows

If the G command is used on a source-code window the T sub-command is chosen automatically and, if the text is found, the window will re-display the line containing it.

Miscellaneous

Ctrl-P Preferences

This permits control over various options within MonSTB. The first three require Y/N answers, pressing Esc aborts and Return leaves them alone.

Screen Switching

Defaulting to On, this causes the display to switch to that of your program only after 20 milliseconds. It should be switched off when a program is about to change a screen's address or resolution and then turned back on afterwards.

Fallow Traps

By default, single-stepping and the various forms of the Run command treat TRAPs, Line-A and Line-F calls as single instructions. However by turning this option On the relevant routines will be entered allowing ROM code to be investigated.

If you are interested in this sort of low-level hackery, you should consider purchasing DevpacST as it provides facilities from recovering from the after effects of interrupting the operating system code.

Relative Offsets

This option defaults to On and affects the disassembly of the address register indirect with offset addressing modes, i.e. xxx(An). With the option on, the current value of the given address register is added to the offset and then searched for in the symbol table. If found it is disassembled as symbol(An). This option is required to show the addresses of your global variables if they are accessed via an address register.

Ignore Case

This option defaults to Off. If it is set to On then if you enter fred in an expression the subsequent search will give the value of the first symbol that matches this, ignoring case, thus finding FRED, fred or Fred. This option is useful for lazy typists who use the same name with different casing.

Show Line Numbers in Source

MonSTB can either show line numbers in your source window in decimal (press D), hexadecimal (H) or not at all (press N). Using hexadecimal line numbers has the advantage that you can use them directly with the # line number operator. This if you can see that you want to execute your program until the line with number 001C then just type U (for run until) #1C. Remember how ever that A0 through A7 and D0 through D7 are register names and take priority over hexadecimal numbers. To enter line number A0 use #$A0.

Decimal line numbers are naturally more civilised but remember that you need to prefix any decimal number with \. If you want to find the address of line 28 decimal, use #\28 not #28.

Auto Lood Source

Using the default settings, MonSTB will automatically load a HiSoft BASIC source file and run your program, ready for you to set a breakpoint in the code. MonSTB loads the source file corresponding to the main file. rather than any include files. You can disable this feature if you do not wish to load this source file or you wish to debug a program written in another language.

Automotic Prefix Lobels

Using the default setting MonSTB will try prefixing symbols by _ and @ if it cannot find a label, so that if you enter start and there is no label called start, the MonSTB will try _start or if this doesn't exist then it will try @start.

This facility is extremely useful since BASIC functions often have an _ added by the compiler. If you are using a mixed-language program, the names may begin with @. In each case, the automatic prefixing allows you to just use the name without bothering about the prefix.

Should there be an assembly language or C name the same as a BASIC name, say test and _test, then you will need to use the _ explicitly to get the BASIC function rather than the C or assembly language one. You can disable this option so that only exact matches of names are supported.

Symbols Option

This allows control over the use of symbols in expressions in MonSTB. It will firstly ask whether the case of symbols should be ignored, pressing Y will cause case independent searching to be used. It will then prompt for the maximum length of symbols, which is normally 22 but may be reduced to as low as 8.

Top Of RAM

This indicates to MonSTB which memory location should be considered the top of memory by the Search Memory (G) command. Normally you will not need to change this as it defaults to the system variable phys_top; but you may need to modify it if you are debugging software that lowers phys_top.

The TT version has two tops of RAM one for ST RAM and one for TT RAM.

Sove preferences

Reply Y to this command to save your current preferences to the file MONST2.INF in the current directory. When MonST2 loads it will read your current preferences from this file. MONST.INF must be in the current directory when MonSTB is loaded.

The TT version has uses MONTT.INF

I Intelligent Copy

This copies a block of memory to another area. The addresses should be entered in the form

```
<start>,<inclusive_end>,<destination>
```

The copy is intelligent in that the block of memory may be copied to a location which overlaps its previous location.

No checks at all are made on the validity of the move; copying to non-existent areas of memory is likely to crash MonSTB and corrupting system areas may well crash the machine.

L List Labels

This opens up a large window and displays all loaded symbols. Any key displays the next page, pressing Esc aborts. The symbols will be displayed in the order they were found on disk.

W Fill Memory With

This fills a section of memory with a particular byte. The range should be entered in the form

```
<start>,<inclusive_end>,<fillbyte>
```

The warning described under the I command about the lack of checks applies equally to this command.

M Modify Address

Included for compatibility with MonST1, equivalent to Alt-A.

O Show Other Boses

Included for compatibility with MonST1, equivalent to Alt-O.

D Chonge Drive & Directory

This allows the current drive and sub-directory to be changed.

Ctrl-Alt-Numeric Dot Reset mochine

Holding down Ctrl and Alt and then pressing the Dot (.) key on the numeric keypad will cause the machine to be reset. Great for Mega ST owners with 1.2 ROMs but without long arms!

Ctrl-E Re-Install Exceptions

This command causes MonSTB to re-install the exception vectors; useful if you want the divide by 0, array bounds and overflow checks to be trapped by MonST rather than as BASIC runtime errors..

This must be used *after* the user's program has modified the exceptions - i.e. when the program has reached at least the label REF0001.

Command Summary

Window Commonds

Alt-A	Set Address
Alt-B	Set Breakpoint
Alt-E	Edit Window
Alt-F	Font Size
Alt-L	Lock Window
Alt-O	Show Other
Alt-P	Printer Dump
Alt-R	Register Set
Alt-S	Split Windows
Alt-T	Change Type
Alt-Z	Zoom Window

Screen Switching

V	View Other Screen
Ctrl-O	Other Screen Mode

Breokpoints

Alt-B	Set Breakpoint
Help	Show Help and Breakpoints
Ctrl-B	Set Breakpoint
U	Go Until
Ctrl-K	Kill Breakpoints
Ctrl-A	Set Breakpoint then Execute
Ctrl-D	GEMDOS Breakpoint

Looding ond Soving

Ctrl-L	Load Executable Program
B	Load Binary File
S	Save Binary File
A	Load ASCII File

Executing Programs

Ctrl-R	Return to program / Run
Ctrl-Z	Single-Step
Ctrl-Y	Single-Step
Ctrl-T	Interpret an Instruction (Trace)
Ctrl-S	Skip Instruction
R	Run (various)

Searching Memory

G	Search Memory (Get a sequence)
N	Find Next

Miscellaneous

Ctrl-Alt-Dot	Reset machine
Ctrl-C	Terminate
Ctrl-E	Re-install breakpoints
Ctrl-P	Preferences
D	Change Drive & Directory
H	Show History Buffer
I	Intelligent Copy
L	List Labels
M	Modify Address
O	Show Other Bases
W	Fill Memory With
Shift-Alt-Help	Interrupt Program

Debugging Stratagem

Hints & Tips

If you have interrupted a program using Shift-Alt-Help or by a Run Until command and have found yourself in the middle of the ROM, there is a way of returning to the exact point in your program which called the ROM. Firstly ensure the Follow Traps option is on, then do Run Until with an expression of sp=a7. This will re-enter MonSTB the moment user mode is restored which will be in your program.

When using Run Until knowing that it will take a quite a while for the condition to be satisfied, give MonSTB a hand by pre-computing as much of the expression as you can, for example

```
(a3>(3A400-\100+M1))
```

could be reduced to

```
a3>xxx
```

where xxx has been calculated by you using the Alt-O command.

If you do use a label with Run Until then explicitly including any leading _ or @ will speed up the table search considerably.

Bug Hunting

There are probably as many strategies for finding bugs as there are programmers; there is really no substitute for learning the hard way, by experience. However, here are some hints which we have learnt, the hard way!

Firstly, a very good way of finding bugs is to look at the source code and think. The disadvantage of reaching first for the debugger, then second for the source code, is that it gets you into bad habits. You may switch to a machine or programming environment that does not offer debugging, or at least not one as powerful you are used to.

If a program fails in a very detectable way, such as causing an exception, debugging is normally easier than if, say, a program sometimes doesn't quite work exactly as it should.

Many bugs are caused by a particular memory location being stepped on. Where the offending memory location is detectable, by producing a bus error, for example, then a conditional breakpoint placed at one or more main subroutines can help greatly. For example, suppose the global variable at address 123456 is is inadventally becoming negative during execution. The conditional expression could be set up as

```
{123456}<0
```

If this method fails, and the global variable is being corrupted somewhere un-detectable, the remaining solution is to Run Until that expression, which could take a considerable time. Even then it may not find it, for example if the bug is caused by an interrupt happening at a certain time when the stack is in a particular place.

Count breakpoints are a good way of tracking down bugs *before* they occur. For example, suppose a particular subroutine is known to eventually fail but you cannot see why, then you should set a count breakpoint on it, then let the program run. At the point where the program stops, because of an exception say, look at the value of the count breakpoint (using Help). Terminate the program, re-load it, then set a stop breakpoint on the subroutine for that particular value or one before it. Let it run and then you can follow through the subroutine on the very call that it fails, to try and work out why.

Exceptions

MonSTB uses the 68000 processor exceptions to stop runaway programs and to single-step, so at this point it would be useful to explain them and what normally happens when they occur on an ST/TT.

There are various types of exception that can occur, some deliberately, others accidentally. When one does occur the processor saves some information on the SSP, goes into supervisor mode and jumps to an exception handler. BASIC programs use some of these for detecting runtime errors such as arithmetic overflow.

When MonSTB is active it re-directs some of these exceptions so it can take control when they occur. You will need to use the Ctrl-E (Re- Install exceptions) command after your program has loaded in order for MonST to regain control of the exceptions that are used by runtime errors.

The various forms of exceptions, their usual results, and what happens when they occur with MonSTB active is shown in the following table (on the next page):

Number	*Exception*	*BASIC gauge*	*MonSTB active*
2	bus error	bombs	trapped
3	address error	bombs	trapped
4	illegal instruction	bombs	trapped
5	zero divide	Runtime error	trapped
6	CHK instruction	Runtime error	trapped
7	TRAPV instruction	Runtime error	trapped
8	privilege violation	bombs	trapped
9	trace	bombs	used for single-stepping
10	line 1010 emulator	fast VDI interface	fast VDI interface
11	line 1111 emulator	internal TOS	internal TOS
32	TRAP #0	bombs	trapped
33	TRAP #1	GEMDOS call	GEMDOS call
34	TRAP #2	AES/VDI call	AES/VDI call
35	TRAP #3	bombs	trapped
36	TRAP #4	Trace Line number	trapped
37-44	TRAP #5-#12	bombs	trapped
45	TRAP #13	XBIOS call	XBIOS call
46	TRAP #14	BIOS call	BIOS call
47	TRAP #15	bombs	trapped

Exceptions 2 to 8 are caused by a programmer error and are trapped by MonSTB.

Exception 9 can remotely be caused by programmer error and is used by MonSTB for single stepping.

Exceptions 10, 11, 33, 34, 45 and 46 are used by the system and left alone.

The rest (i.e. the unused TRAP exceptions) are diverted into MonSTB, but can subsequently be re-defined to be exploited by programs if required.

The TRAP #4 vector is only modified if you using the TRON command,.

The 'bombs' entry in the table above means that the ST will attempt to recover from the exception, but it is not always successful.

When an exception occurs, the ST prints on the screen a number of *bomb* shapes (or *mushrooms* on the old disk-loaded TOS), the number being equal to the exception number. Having done this, it will abort the current program (losing any unsaved data from it) and attempt a return to the Desktop.

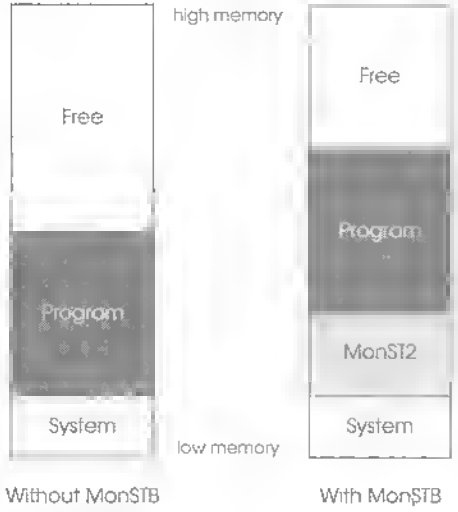
If the exception was caused by or resulted in important system variables being destroyed then the attempt may fail and the machine will not recover.

Occasionally very nasty crashes can cause the whole screen to fill with bombs (or mushrooms) which looks very impressive, but is not very useful!

Memory Layout

The usual versions of MonSTB co-reside with programs being debugged; that is, they are loaded, ask for a filename, and load that file in together with any labels.

It is useful to examine the usual logical memory map both with and without MonSTB, shown below:



The actual code size of MonSTB is around 25k, but in addition it requires an additional 32k of workspace. This may seem large but it is required for the copy of the ST screen memory saved by MonSTB; this is a most useful feature of the debugger.

Exception Analysis

When an unexpected exception occurs, it can be useful to be able to work out where and why it occurred and, possibly, to resume execution. Often a quick curse and a look at your source code may get your program working quicker though!

Bus Error

If the PC is in some non-existent area of memory then look at the relevant stack to try and find a return address to give a clue as to the cause. If the PC is in a correct area of your program then the bus error must have been caused by a memory access to non-existent or protected memory. Recovering from bus errors and resuming execution is generally not possible.

Address Error

If the PC is somewhere strange the method above should be used, otherwise the error must have been caused by a program access to an odd address. Correcting a register value may be enough to resume execution, at least temporarily.

Illegal Instruction

If the PC is in very low memory, below around $30, it is probable that it was caused by a jump to location 0. If you use MonSTB to look here you will see a short branch together with, normally, various ORI instructions (really longword pointers) and eventually an illegal instruction.

Privilege Violation

This is caused by executing a privileged instruction in user mode, normally meaning your program has gone horribly wrong. Bumping the PC past the offending instruction is unlikely to be much help in resuming the program.

Using MonSTB with other languages

A major feature of MonSTB is its ability to use symbols taken from the original program whilst debugging. MonSTB supports two formats for label information - the DRI standard, which allows up to 8 characters per symbol, and the HiSoft Extended Debug format, allowing up to 22 characters.

Most of HiSoft's language products support both formats (for example, DevpacST, Lattice C 5 and FTL Modula-2) and many other vendors' compilers and linkers have an option to produce DRI-format debugging information.

The line number information format is, at the present time, specific to HiSoft BASIC although MonSTB also reads the line number information output by Lattice C.

Using MonSTB with multi-module programs

MonSTB will initially read the line number information and source file for the main BASIC program assuming that you have switched on line number information globally. If you wish to debug more than one file at once, then you can switch to another file by explicitly loading the appropriate source file using the A command.

However if you are only interested in debugging one include file, you can enable line numbers in an include using `rem $option &+` and then disable them using `rem $option &-` within that same include file. The include source file will then be loaded first.

For Devpac MonST2 Users

If you are used to the version of MonST that is part of Devpac ST version 2, here are the differences:

- Source line numbers can now be displayed in either hexadecimal or decimal. This is set using the Preferences command.
- Using the default settings, MonSTB will automatically run the program until the label REF0001 and load the source file corresponding to the first debug information in the file.

- The operator # is used to give the address corresponding to a given BASIC line number. To use this you need to use the compiler's -d option. The argument to # is a general MonSTB expression and so when using a number this should be in hexadecimal or prefixed by \ for decimal. Thus #10 and #\16 both give the address of line 16 of the program.
- The ASCII load command will change the action of the # operator if the appropriate debug information is available.
- MonSTB has no support for disassembly to disk. Dissassembly to the printer is only available via Alt-P.

Appendix A
Reserved Words

On the following page is a complete list of the reserved words that are included within HiSoft BASIC.

Normally, these words may not be used as sub-program or label names or as variable names; you can, however, remove a particular reserved word using the - compiler option. This is included for maximum compatibility with other versions of the BASIC language. See *Chapter 3* of the *User Manual* for more details. of removing and re-naming HiSoft BASIC reserved words.

Most of these words are built-in HiSoft BASIC language features and,,as such, are described in the *Command Reference* chapter; you should note, however, that not all these words will be described directly in this chapter. For example, `TO` is a reserved word but will not have an entry in the *Command Reference* since it is part of the `FOR...NEXT` syntax.

In addition, there may be some words that are included for compatibility with other languages that are not described in *Command Reference*.

ABS	ACCESS	ALIAS	AND	APPENO
AS	ASC	ATN	AUTO	BAR
BASE	BEEP	BIN$	BLOAD	BREAK
BSAVE	BYVAL	CALL	CALLS	CASE
COBL	CDECL	CHAIN	CHOIR	CHR$
CINT	CIRCLE	CLEAR	CLEARW	CLNG
CLOSE	CLOSEW	CLS	COLOR	COMMANDS
COMMON	CONST	CONTRL	COS	CSNG
CSRLIN	CURDIR$	CVO	CVI	CVL
CVS	DATA	OATES	OECLARE	OECR
DEF	OEFOBL	OEFINT	OEFLNG	OEFSNG
DEFSTR	OIM	DO	ELLIPSE	ELSE
ELSEIF	ENO	ENVIRON	ENVIRON$	EOF
EQV	ERASE	ERL	ERR	ERROR
EXIT	EXP	FEXISTS	FIELD	FILES
FILL	FIX	FOR	FORMATO$	FORMATI$
FORMATL$	FORMATS$	FRE	FREEFILE	FULLW
FUNCTION	GB	GEMSYS	GET	GETCOOKIE
GOSUB	GOTO	GOTOXY	HEX$	IF
IMP	INCR	INKEY$	INP	INPUT
INPUT$	INSTR	INT	INTIN	INTOUT
IS	KEY	KILL	LBOUNO	LCASE$
LEFT$	LEN	LET	LIBRARY	LINE
LINEF	LOC	LOCAL	LOCATE	LOF
LOG	LOG10	LOG2	LDOP	LPOS
LPRINT	LSET	LTRIM$	MAX	MIOS
MIN	MKO$	MKDIR	MKI$	MKL$
MKS$	MOO	MOUSE	NAME	NEXT
NOT	OCT$	OFF	ON	OPEN
OPENW	OPTION	OR	OUT	OUTPUT
PALETTE	PCIRCLE	PCOPY	PEEK	PEEKB
PEEKL	PEEKW	PELLIPSE	POINT	POKE
POKEB	POKEL	POKEW	POS	PRESERVE
PRESET	PRINT	PSET	PTSIN	PTSOUT
PUT	RANDOM	RANDOMIZE	READ	REOIM
REM	REMAINOER	REPEAT	RESET	RESTORE
RESUME	RETURN	RIGHT$	RINSTR	RMDIR
RND	RSET	RTRIM$	RUN	SAOD
SCREEN	SEG	SELECT	SGN	SHARED
SIN	SOUNO	SPACE$	SPC	SPEEKB
SPEEKL	SPEEKW	SPOKEB	SPOKEL	SPOKEW
SQR	STATIC	STEP	STICK	STOP
STR$	STRIG	STRING$	SUB	SWAP
SYSTAB	SYSTEM	TAB	TAN	THEN
TIME$	TIMER	TO	TROFF	TRON
UBOUNO	UCASE$	UNTIL	USING	VAL
VARPTR	VARPTR$	VOISYS	WAVE	WEND
WHILE	WIOTH	WINDOW	WRITE	XOR

Appendix B Compiler Options

^	Output Loadbits	output
-	Remove reserved words	other
!	Enable variable exports	standard
#	No "FN"s in libraries	standard
$	Dump Tokens	other
%	Remove inter-sub-progam jumps	advanced
&	Add MonSTB line numbers	debug
*	Use old style doubles in files	advanced
.	Suppress compiler titles	other
@	Pre-tokenised file	standard
[	Array Warnings	standard
]	Allow undefined sub-programs	advanced
A	Array Checks	standard
B	Break Checks	standard
C	Continue on compiler errors	advanced
D	Use Extended Debug	debug
E	Error Messages	standard
F	Output Filename	standard
G	Force GEM program	advanced
H	Maximum Labels	advanced
J	Desk Accessory Size	advanced
K	Keep size	advanced
L	Leave Size	advanced
M	Maths Stack Size	advanced
N	Add Line Numbers	standard
O	Overflow Checks	standard
P	Pause Checks	standard
R	Return Stack Size	advanced
S	Add Debug information	debug
T	Temporary String Descriptors	advanced
U	Underlines in variables	standard
V	Variable Checks	standard
W	Suppress Compiler Warnings	advanced
X	Stack Checks	standard
Y	Suppress Default Window	advanced
Z	Finish without waiting for a keypress	other

Appendix C
Error Messages

GEMDOS Error Numbers

This appendix details the GEMDOS error numbers and their meanings. The error numbers shown are those displayed from within the HiSoft BASIC editor - when calling GEMDOS from your own programs these values are negative.

0	OK (no error)	32	Invalid function number
1	Fundamental error	33	File not found
2	Drive not ready	34	Path not found
3	Unknown command	35	Too many files open
4	CRC error	36	Access denied
5	Bad request	37	Invalid handle
6	Seek error	39	Insufficient memory
7	Unknown media	40	Invalid memory block address
8	Sector not found	46	Invalid drive
9	No paper	49	No more files
10	Write fault	50	Disk full (not a GEMDOS error - only produced by the editor)
11	Read fault	64	Range error
12	General error	65	Internal error
13	Write protect	66	Invalid program load format
14	Media change	67	Setblock failure due to growth restrictions
15	Unknown device		
16	Bad sectors on format		
17	Insert other disk		

Runtime Errors

These are errors produced by, or returned from, running compiled programs. They are listed in numeric order for easy reference when messages are not included in the compiled program and for the ERR function. On the next page they are listed in alphabetic order with explanations as to their meaning.

3	RETURN without GOSUB
4	Out of data
5	Illegal function call
6	Overflow
7	Out of memory
9	Subscript out of range
10	Redimensioned array
11	Division by zero
13	Type mismatch
16	String formula too complex
20	RESUME without error
23	Line buffer overflow
31	Wrong number of dimensions
50	FIELD overflow
51	Internal error
52	Bad channel number
53	File not found
54	Bad file mode
57	Device I/O error
61	Disk full
62	Input past end
63	Bad record number
64	Bad file name
67	Too many files
68	Device unavailable
70	Disk write protected
75	Path/file access error
76	Path not found
77	BREAK pressed
78	Fatal bus error
79	Fatal address error
80	Array not dimensioned
81	Sub-program not present

Run-time Errors Alphabetically

Array nat dimensianed

You have used an array that has not been dimensioned. This only occurs when the Array Check Warnings option is enabled. In generally means that you have mis-spelt the array name here or have forgotten to DIMension it..

Bad channel number

Valid channel numbers are from 1 to 255 inclusive, plus 256 for the default printer channel that is used by LPRINT. In addition windows use channel numbers 257 upwards.

Bad file made

You are trying open a channel with an invalid mode string, or trying an input/output operation on a channel that cannot support it, e.g. PRINTing to a file opened for INPUT.

Bad file name

The filename is invalid, either because it is too long or because it contains invalid characters.

Bad record number

A record number of 0 is not valid in a PUT or GET statement.

BREAK pressed

Ctrl-C was pressed during screen input or output. This error cannot be trapped by ON ERROR - if you wish Ctrl-C to be ignored then turn the break checks option off. Pressing Shift-Alt-Help when a program which was compiled to memory is running will also produce this error.

Device I/O errar

A physical error has occurred during an input/output operation.

Device unavailable

You are trying an operation on a device that cannot support it, such as drawing a circle on a disk file.

Disk full

Disk write protected

Divisian by zera

Fatal address errar

Address errors are *processor exceptions* caused by a memory access at an odd address, such as PEEKL(&H20011). This error is fatal and cannot be trapped. If a program is compiled to disk this error will produce 3 bombs.

Fatal bus errar

Bus errors are *processor exceptions* caused by a memory access at an address in protected or non-existent memory. If you really want to access protected memory use the ST BASIC compatible PEEK or POKE functions. This error is fatal and cannot be trapped, and if it occurs in a program compiled to disk it will produce 2 bombs.

FIELD averflow

A FIELD statement has attempted to use more space than specified in the record size when OPENed, or PRINT# to a random file has filled the current record.

File nat faund

Illegol functian call

This error can be caused by a multitude of things and means a parameter was not in the range required by a function. The module name and line number can be used to track down the error.

Input post end

You have tried to read past the end of a file.

Internal errar

This should never happen. It almost certainly means that your program has destroyed part of the heap or the program itself.

Line buffer averflaw

A text line in a file is too long for the current line buffer. You can increase the size of this buffer by modifying the long word at SYSTAB+68.

Out of data

A READ has been attempted when no more DATA is available.

Out af memary

Normally this means the heap is full, which is the area of memory used for storing strings and arrays. If the error is in module MALLOC then the GEMDOS pool of memory is full. This can be increased by the use of the Keep and Leave options described in *Appendix B* and *Chapter 3* of the *User Manual*.

Overflaw

A result of a numeric calculation is too large to fit into the required type. This can occur when you don't expect it, for example the line

```
test!=32767+1
```

will produce it, as two integers are added together using integer arithmetic. The correct result can be obtained by forcing single-precision arithmetic:

```
test!=32767!+1
```

Poth nat found

An invalid path was specified in a DOS command.

Poth/file occess error

You are not permitted to do that operation with that file, such as trying to KILL a read-only file.

Redimensioned orray

An existing array must be ERASEd before DIMmed for a second time.

RESUME without errar

A RESUME command will only work from within an ON ERROR handler.

RETURN withaut GOSUB

A RETURN statement was executed but not from a section of the program which had been called with GOSUB. This error will only occur with the stack checks option turned on (see *Appendix B* and *Chapter 3* of the *User Manual*).

String formula tao camplex

String operations use temporary descriptors for intermediate results, and it is remotely possible to run out and produce this error. You can use the String Descriptors (T) compiler option to increase this.

Sub-progrom not present

The means that you have called an un-defined sub-program or function. Normally this is checked by the compiler so this error will only occur if you have used the Allow undefined sub-programs option ([) has been used. If you are using the HiSoft GEM Toolkit it means that you've enabled a particular facility (e.g. menus) without providing the appropriate sub-program (`ProcessUserMenus` in this case).

Subscript out of ronge

An array subscript used is larger than that specified in the dimensioned statement, negative, or 0 if `OPTION BASE 1` is used.

Too mony files

A maximum of 255 channels may be opened at once from BASIC. In addition GEMDOS limits the number of simultaneous open disk files to approximately 70.

Type mismotch

A `READ` was attempted into a numeric variahle but the data was found to be a string.

Wrong number of subscripts

An array has been referenced with a different number of dimensions to the numher last `DIM`med. Unlike other compilers this is a run-time error as dynamic HiSoft BASIC arrays can be `REDIM`med with different numbers of dimensions.

Compilation Errors

When the compiler detects an error or something that may be an error (a warning) it generates a message.

The message is prefaced by the error number and followed by the line and file in which the error was detected. In the case of warnings the compiler will continue automatically. After an error it will ask you if you wish to continue. If you type `n` or `N` (for no) you will be returned to the editor. If you hit any other key compilation will continue.

When you return to be editor you can use Alt-J to move to the next error with the error message displayed in the status line. If you have a large number of errors the editor may not be able to remember them all. Alt-J goes to the next error regardless of the position of the cursor; it will switch windows is required. To got to a previous error using Ctrl-J. The editor takes account of any insertions or deletions automatically so that unless one error (like a mistake in a definition) has caused multiple errors you should only need to compile once.

There's also the Shift-Alt-J command which finds the next error after the cursor in the current window. It is the appropriate one to use if you have got a number of include files and want to fix all the errors in one file before going on to the next one. You can also use it to find the first error in a file by typing Alt-T (to go to the top) and then Shift-Alt-J.

Normally the error message should be fairly obvious. The following list gives some extra hints for some of the error messages.

Occasionally the compiler will spot errors somewhat later than you might expect. This is usually because the text up to the point it has read is allowed in certain contexts. If you have missed something out at the end of a line, then the error may be detected at the beginning of the next line. Note that, except in the case of missing sub-programs, line numbers or labels, the error in your program can not be *after* the point where the error was detected.

On occasions the compiler will generate more than one error message as a result of a single error in your program; do not be put off by this. If you get confused, just re-compile.

If you have a very badly formed source file, the compiler may slow down considerably. It is probably a good idea to type `n` to the continue prompt. Incidentally, if you start a compilation of a large program you can break out and returned to the editor using the key combination Alt-Shift-Help when using the integrated compiler.

It is possihle that some error messages may have been added to the compiler; only if an error is generated without an error message is this a possible bug in the compiler. If you do get an error number without a message, please tell us.

Compiler Error Messages

In the following list many of the messages give an identifier, reserved word or symbol, this is displayed instead of the % in the message.

1 Con't initiolise the compiler

The compiler can't find the HBASIC.LIB file, or there is an attempt to creat too large a label table.

2 ON... should be followed by GOTO/GOSUB

May occur if the expression is misformed.

3 Undefined identifier %

Occurs within sub-programs and functions if the V option is on. See *Appendix B* and *Chapter 3* of the *User Manual*.

4 Unterminated string in data

5 Line number/lobel missing in GOTO/GOSUB % found instead

This also occurs in ON GOTO/GOSUB/ERROR and RESUME statements if a line number or label is missing.

6 END DEF ossumed

7 END SUB ossumed

Error messages 6 and 7 both occur if you attempt to nest sub-program or function definitions.

8 END DEF where END SUB expected

9 END SUB where END DEF expected

Error messages 8 and 9 are both warnings.

10 Letter expected ofter DEFINT etc

11 Letter expected after - in DEFINT etc

13 Tao many ENDs/NEXTs ar operand missing

This error is generated in two different contexts, either when you have too many ENDs or NEXTs or sometimes when omitting one of the operands to a dyadic operator (e.g. *) in an expression.

14 Numeric expressian expected (nat string)

Many possible causes.

15) expected instead of %

Many possible causes.

16 Unterminated string

17 Unexpected chorocter in source

This is a warning, the offending character will be ignored.

18 FN must be fallawed by a name.

You can't use FN on its own as a function name.

19 Bad line number (% is not positive)

Or 0 not allowed in this context.

20 Bod line number (% is taa large)

21 Bad line number (% has fractian/ exponent)

Or is far too large.

22 Line number % not found

23 Line number % nat faund

24 Porometer (%) may nat be used as FOR loop identifier

Use a local variable instead.

25 Nome (not %) expected in porameter list

Have you used a reserved word?

27 CDECL may only be used in DECLAREd sub-pragrams

But you have tried to use it in a SUB/FUNCTION definition.

28) expected at end af parameter list. % found instead

Can also be caused by missing out the comma.

29 Nome expected instead of %

Many possible causes.

30 Statement only allowed in sub-program or function

These statements are LOCAL, SHARED, STATIC, EXIT DEF/FUNCTION/SUB.

32 Label % defined twice

33 COMMON must be followed by SHARED

HiSoft BASIC does not allow any other form of `COMMON` statement.

34 Line number/label expected instead of %

Can occur if an expression is badly formed in an `ON...GOTO/GOSUB`.

36 Error during optimisation

Refer to the message given by the code generator.

37 Constant % may not be used in parameter definition.

You have tried to use a constant that you've already defined as a formal parameter in a `SUB`, `DEF FN` or `FUNCTION` definition. Use another name either for the constant or the parameter.

38 Too many lines in program

You may not have more than 16383 lines in a single program. See the *User Manual : Concepts* chapter for other compiler limits.

39 Internal Error (bad source on pass 2)

Can occasionally be generated by very badly formed source.

40 Expression mismatch

Normally caused by missing operands.

41 END FUNCTION expected before here

You have attempted to nest a sub-program or function definition inside a `FUNCTION`.

42 Expression too complex (too many operators)

More than twenty operators pending.

43 Expression mismatch

44 Expression too complex

More than twenty operands pending.

45 Expression syntax

46 Expression syntax

Normally caused by missing out an entire expression.

47 FUNCTION or SUB expected after DECLARE

48 FUNCTION or SUB declared but not present

You have used a DECLARE statement for this function but not actually defined with the corresponding SUB or DECLARE statement. If you think you have, check the spellings carefully.

49 SUB name % used in expression

S0 Expression mismatch: % is not a unary operator

S1 Expression mismatch: No unary string minus

S2 Expression mismatch

53 Illegal type combination

Two strings used with arithmetic operators other than +.

54 Illegal type cambinatian (nat string)

A string expression and a numeric expression have been used with an operator.

55 Parameter % appears twice

56 Illegal type cambinatian (nat string)

String could not be coerced to numeric type.

57 % is nat a variable ar the current functian

Using other function names is not allowed on the left hand side of assignments.

58 Variable is wrang type

For example, if you pass a double array instead of an integer array to a sub-program.

59 Open bracket expected instead af %

Many possible causes.

60 Camma expected instead af %

Many possible causes. Could be that an expression is mis-typed.

61 Semi-calan expected instead af %

Many possible causes.

62 Extra characters at end af statement % is first

Perhaps you didn't expect the statement to be over so soon. Check your expressions.

63 END DEF assumed at the end af pragram

64 END SUB assumed at the end af pragram

65 Cade generatian failed

See the message given by the code generator - the most popular one is disk full!

67 Bad aptian specified

68 (expected in CALL statement instead af %

When using the CALL statement for a sub-program with parameters, you must follow the sub-program name with an open parenthesis.

69 Subrautine % nat faund

To CALL a variable use CALL LOC.

72 = expected instead af %

Many possible causes.

74 Unknawn meta-cammand %

This error means that you have used a meta-command (after rem $) that is not supported by HiSoft BASIC. If you are writing a new program check that you have spelt it correctly; if you are porting a program from another compiler, check to find out what it does!

75 Structure table full

The internal table used by the compiler to store the details of parameter lists, SHARED and local variables is full. If you are importing a lot of global variables many times, make them DIM SHARED.

76 LINE must be fallawed by INPUT nat %

To plot a line use the LINEF statement.

78 FOR variables must be simple variables (nat % which is an array)

79 FOR variable % can't be a string

80 TO nat % expected in FOR statement

Is your initial assignment to the FOR variable correct?

81 Tokens file too young

The pre-tokenised .T file that you are using was compiled with an older version of the compiler. Re-make the .T file with this compiler.

82 Tokens file corrupt

83 BASE not % expected ofter OPTION

84 OPTION BASE must be followed by the number 0 or 1 not %

85 Tokens file % not found

86 Connot delete % os o reserved word

As it isn't a reserved word.

87 Bod extension for output file: .%

The only valid extensions are .O (for linkable), .TOS, .TTP, .PRG, .APP, .ACC and .GTP.

88 % connot stort o stotement

89 Extro ELSE

90 ELSEIF must be followed by THEN not %

91 % not ollowed ofter END

92 Mismotched NEXT should be %

93 END IF expected before here

94 END REPEAT expected before here

95 NEXT expected before here

96 END SELECT expected before here

97 WEND expected before here

98 LOOP/WEND expected before here

Errors 93 to 98 may occur if you have omitted the start of the structured statement in the error line.

99 Nome required ofter SUB or DEF. % found instead

Is it a reserved word? See *Appendix A*.

100 Identifier % redefined

In sub-program or function definition.

101 Option volue too lorge

The only option that may have a parameter bigger than 32767 is the Load Bits (^) option.

102 Nome expected ofter LET (not %)

103 GOTO, THEN or end of line expected ofter IF expression not %

104 Return stock of %K used

This warning is given when the return stack is more than 200K because in previous versions of HiSoft BASIC the argument to this option was in bytes rather than kilobytes. A return stack of this size is only needed in extremely recursive programs.

105 Unexpected END SUB or END DEF

Occurs when not in a function or sub-program definition.

106 CALL missing ot stort of stotement

This is a warning. For more information see the *Concepts* chapter in the *User Manual*.

107 Unterminoted control constructs

Occurs at the end of sub-programs, user-defined functions and sub-programs.

108 Function or sub-progrom redefined in librory %

109 Unknawn REPEAT laop in EXIT

110 Windaw stotement misfarmed

111 Semi-calon or comma expected

Many possible causes.

112 REDIM PRESERVE of orroys af more than ane dimension nat ollowed

113 AS or , expected instead af % in OPEN statement

Occurs in `OPEN`, `NAME` and `FIELD` statements. Perhaps an expression is wrong.

114 CONSTants must be integers nat %

115 CONST % can not be assigned ta

116 - expected instead of % in grophics GET

117 WINDOW SYSTEM/STOP con only be used in desk occessories

118 % is not a label

Your source is probably severely malformed.

119 (expected instead of % in graphics GET ar PUT

120 Arroy expected but ordinary varioble % faund

121 Argument ta VARPTRS must be a subrautine nome not %

123 INCLUDE file % nat faund

125 Value parometer must not be arroy

127 Library must be string literol not %

Have you remembered the quotation marks?

128 Cannat open library

129 Library badly farmed

The `HBASIC.LIB` file is probably corrupt.

130 Taa many porometers in statement

131 Sub-progrom % not faund

To `CALL` a variable use `CALL LOC`.

132 GOTO expected after ON ERROR not %

134 SELECT voriable must anly be o simple vorioble nat %

135 LOOP/WEND expected before here

136 PALETTE USING must be followed by orroy ot %

137 ON/OFF expected after STRIG

Appendix D
The ASCII Table

Here is the 8-bit ASCII representation of the ST/TT's character set:

The ST/TT ASCII set

The most significant four bits of the ASCII representation are shown down the left side whereas the least four significant bits are across the top so that, for example:

4C (4*16+12=76 decimal) represents L

7B (7*16+11 = 123 decimal represents {

Appendix E
WERCS HRD file format

.HRD files consist of a header record, any number of variable length data records and then an end-of-file record.

HRD Header record

Name	Size	Meaning
version	word	1 at present
autonaming	byte	1 if auto-naming selected 0 if no auto-naming
langflag	byte	1 if C, 2 if Pascal, 4 if Modula-2, 8 if FORTRAN, 16 if assembler, 32 if BASIC
autosnap	byte	0 if no character-snap 1 if half character-snap 2 if full character-snap
casing	byte	0 if mixed 1 if upper 2 if lower
autosizing	byte	1 if auto-sizing 0 if no auto-sizing
reserved	byte	not used at present

HRD Data Record

Name	Size	Meaning
type	byte	0 if Form, 1 if Menu, 2 if Alert, 3 if Free String, 4 if Free Image, 5 if object (rather than tree), 6 if end-of-file record, 7 if record names a prefix rather than a name.
reserved	byte	not used at present
treeindex	word	number of tree
objindex	word	if object then object number within tree
name	varies	Name terminated with a single null

Appendix F Linking with C and Assembler

This Appendix is intended for assembly-language and C programmers and details linkage with these languages, together with the memory maps and register usage of compiled programs. If the previous sentence didn't make any sense then stop reading this Appendix now.

Code Generation

A BASIC source program is converted into true machine-code, there are no P-codes or interpretive run-times. The code produced distinguishes between the program area and the data area. The program area is what is written to the disk or to memory and is position dependent code, relocated either by the GEMDOS loader in the case of disk files or the code generator itself with programs compiled directly to memory. All program code executes in user mode and is compatible with 68010, 68020, 68030 and 68040 processors.

Figure F-1 shows the overall memory map of a compiled program. Note the gap between the program itself, held in the Text segment, and the data area, held in the BSS segment. When a program is run from disk these areas are continuous, but when run from memory using the editor or when in ROM they are not.

Register Usage

Several registers are committed to special purposes within a compiled program. These are:

A3 - Library Pointer

In order to minimise the space and time taken for run-time library calls, register A3 is dedicated to point to the run-time library, with a $8000 offset to allow a maximum of 64k for the whole library.

Library calls from within the compiled code are of the form

```
JSR   -offset(A3)
```

Library calls from within the library itself do not use A3, they use BSR statements and are resolved by the code generator during compilation.

A4 - Local Variable Stack Frame

At the very beginning of functions and sub programs a LINK instruction is done to allocate space on the stack for local variables (and function results) and to establish a register that can be used for accessing parameters. Only space for numeric variables are immediately allocated using LINK; arrays and string descriptors are allocated afterwards using a library call. For example a sub-program which has one local integer variable starts with the instruction

```
LINK  #-2,A4
```

Functions and sub programs finish with a corresponding

```
UNLK  A4
RTS
```

A5 - Data Area Painter

The startup code of a compiled program sets up A5 to point to the data area of the program which of course is always RAM. At the start of the area are the run-time globals, followed by the desciptor table (descriptors are described later). Next is the global variable area, used for storing numeric variables. There is a 32k limit on the total size of these globals, but is would take a massive unstructured BASIC program to require such a number of globals. The static arrays follow this; there is no 32K limit on these, but those within this array are accessed more quickly.

A6 - Maths Stack

This is a special stack used for storing intermediate results of numeric calculations.

A7 - Machine Stack

The regular machine stack used for return addresses and local variables (using A4).

D7 - Tap af Stack

This register is used to hold the current value from an intermediate expression, be it a single precision numeric value (in the ST version), a long or short integer. For strings D7 is used to hold a pointer to the descriptor for that string.

D6 - Tap af Stack Extensian

This register is used in conjunction with D7 to hold long results of type double on the ST version.

FP0 - Flaating paint tap af stack

In the TT version the floating pointer register FP0 is used to hold intermediate floating point results of both single and double precision.

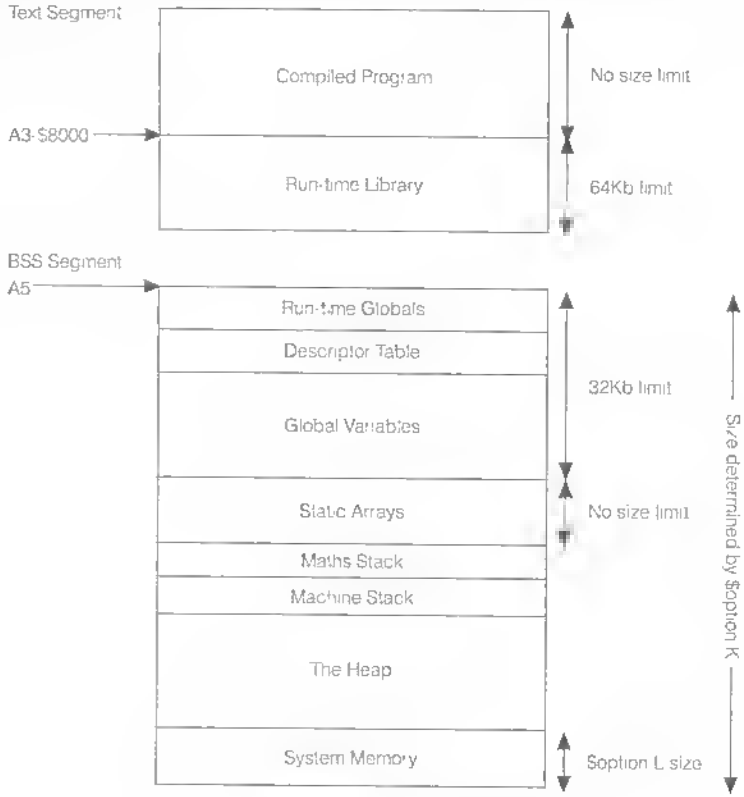


Figure F-1 Compiled Program Memory Map;

Startup Options

There are three different versions of the startup code, determined by the use of the `REM $option L`, `REM $option K` and `REM $option J` meta commands as described in *Chapter 3* of the *User Manual*.

Note that both non-Desk Accessory versions of the GEM startup code check for the presence of GDOS and, if found, attempt to open a virtual workstation to the screen according to GDOS rules, allowing use of multiple fonts and devices if required. Similarly the `WINDOW SYSTEM` command will check for the presence of GDOS when it is invoked from a Desk Accessory.

Low Level Debugging

Finding Your Way

In addition to using the MonSTB line numbers option, you'll probably also find it easier if you use the Add Line Numbers (N) option which adds instructions of the form

```
MOVE.L  #$AAAABBBB,(A5)
```

to the program. The hex number `AAAA` is the physical line number i.e. the line number displayed by the editor, while the hex number `BBBB` is the last actual line number given in the source. These can be very useful for both finding particular lines and working out where you are in the program.

If the BASIC program has the TRON statement anywhere in it then line numbers are coded using the sequence

```
TRAP  #4
DC.L  $AAAABBBB
```

Note that MonSTB also 'understands' about the way that HiSoft BASIC deals with in-line strings. These are really a sub-routine call (to str_constant) followed by the length of the string and its actual data. Fortunately this is disassembled as:

```
STRING "data"
```

so that you may just skip over it using Ctrl-T.

Note that you may see `NOP` instructions within the compiled code; don't be alarmed. These are produced by the code generator because on its first pass it leaves room for a `JMP absolute` instruction when program flow changes, but on pass 2 it notices that the destination is within range for a four byte `BRA`, so it has to add the `NOP` (it does not optimise to `BRA.S` as these take the same time to execute). As the `NOP`s never get executed there is no speed penalty, but there is a size increase. This is worthwhile; the result is that there are no size limits on compiled programs.

The Heap and Descriptors

Crucial to the operation of HiSoft BASIC compiled programs is the area of memory known as the *heap*. BASIC is one of two common languages (the other is LISP) that requires dynamic garbage collection. Owing to the way strings in the language work it is necessary to allocate memory for them as required, then, when it runs out, to re-use all the memory no longer needed. This re-allocation is known as *garbage collection*. Many compilers and even some interpreters do not garbage collect and, as a result, certain operations can cause out-of-memory errors even though there is a lot of unused memory left.

HiSoft BASIC has a very advanced memory management system (which is hidden from the user normally) whereby any memory allocation request can cause a garbage collect to occur in order to satisfy the request. The heap itself is a large block of memory from which allocations for string variables and arrays take their memory.

At the bottom of the heap (low memory) are all the string variables, while at the top are all the arrays. Strings work their way upwards, while arrays grow downwards. Should they ever meet, a garbage collect occurs which deletes all unused strings and moves existing ones around as required. It is important to note that arrays never move in memory as a result of a garbage collect; a dynamic array can only move when you `REDIM` or `ERASE` any other array; static arrays don't move at all.

As items on the heap are liable, without warning, to move about, ordinary pointers are useless.

For this reason strings and arrays are accessed via descriptors, which exist normally in the global area and which themselves contain actual pointers to the data on the heap. As the memory manager knows where all the descriptors are it can update their pointers when a garbage collect occurs.

Incidentally, the garbage collector itself is very fast; for example it can compact around 350k of fragmented heap in under 2 seconds on a standard 8MHz 68000, so there is never any noticeable delay in the running of a program should it have to garbage collect.

Memory Formats

Single-precision Floating Point

These use the Motorola Fast Floating Point (FFP) format. The format is unusual by most standards, but was designed solely with the 68000 architecture in mind, and is as a result very fast. It is the same format as used by ST BASIC, so random access files created with the interpreter should be directly usable within the compiler.

Single Precision

The sign bit is 0 for positive numbers and 1 for negative numbers. The mantissa has an implied binary point at bit 32 and thus ranges in value from 0.5 to <1.0. The exponent is held in excess -64. The number zero is represented with 32 bits of zero.

Double-precision Floating Point

These use the IEEE format double-precision floats, each occupying 8 bytes, i.e. two longs. On the ST version, doubles are actually stored in variables in reverse-long order due to the way the MOVEM instruction works. On the TT version they are stored in there 'natural' order as the FPU is used.

Double Precision Format

The sign bit is 0 for positive numbers and 1 for negative numbers. The mantissa has an assumed bit of 1; if present it would be at bit 52. The exponent is held in excess-1023. The number zero is represented with 64 bits of zero.

Linking or Libraries?

Although this version of BASIC has many powerful features and extensions, occasionally there is a command or function that is not part of standard BASIC. Additionally, a specific task can be very time critical and need all the speed it can get. For these reasons, HiSoft BASIC has the ability to incorporate assembly language subroutines in two ways. You can also link with functions that are written in Lattice C 5.

If you are using assembly language, you have the choice of writing a library or producing linkable code. Libraries have the advantage that once you have written the routine they can be used in exactly the same way as our GEM libraries with no link step required. However code that is used in libraries must be position independent, it cannot access your program's global variables directly and must fit within the 64K of space allocated to the runtime library. If you are modifying your assembly language routine a lot, you'll need to re-make the HBASIC.LIB file after each change. DevpacST version 1.2 or above is required for this.

Using linkable code has the advantages that you can access your global variables directly which can be a big 'win' if the routine is time critical, and the code may be position dependent and as large as you wish. The disadvantage is that you must link you BASIC and assembly code with the CLink linker each time you change either the BASIC or the assembly language.

You'll need DevpacST 3, DevpacTT or Lattice C 5 to produce linkable code.

Assembler utility routines

Before discussing the mechanics of linkable code and libraries in detail, we will discuss three assembly language routines that can be used when using either method:

get_array

takes:	A0	the array descriptor
	D0.W	the number of dimensions the passed array should have
returns:	A2	the address of the first element in the array
	D4.L	the total length in bytes taken up by the array elements
registers used:	D0,D4, A1,A2	

get_string

takes:	A0	the string descriptor
returns:	A1	the address of the string
	D4.L	the length of the string
registers used:	A0,A1,D4	

make_string

takes:	A0	the string descriptor of a string-variable; the descriptor of a string value will have no effect if passed to make_string
	A1	the address of your copy of the string
	D4.L	the length of the string to be created
registers used:	D0-D4, A0-A2	

This call allows a string parameter passed by variable to be safely modified by the caller. A value string parameter passed to make_string will have no effect.

Linking

As we have seen above, BASIC has a much more complex environment and initialisation procedure than C, so it is only possible for a BASIC program to call C functions; it is *not* possible for C programs to call BASIC code. In addition there are certain conventions which make this process more complex, so calling assembly-language code allows more flexibility.

External Definition

In order to call C or assembly-language the compiler allows a program to use a special sort of DECLARE statement to indicate that a function or sub-program is written in C or assembler. Using this will automatically cause the compiler to produce linkable (rather than executable) code. If you haven't used the Output to File name (F) compiler option, the name of the output file with have .o added to it (minus the .bas extension).

The DECLARE...CDECL statement

The special form of the DECLARE statement is as follows:


```
DECLARE {SUB|FUNCTION} subname CDECL
[ALIAS "externalname"]
[(param_list)]
```

The ALIAS clause is optional. The string following indicates the exact external name for the function. If an ALIAS clause is not specified the name (without any type specifier) is made lower-case and an under-score (_) character inserted at the front. This is suitable for linking with Lattice C compilers. Thus a function called cname% or a sub-program called CNAME will both use the name _cname, if there is no ALIAS clause.

The parameter list is like that of a BASIC SUB-program or function. That is, it specifies the types of the parameters, how many parameters there are, and whether the parameters are passed by value or reference. Normally the BYVAL keyword should be used to indicate that the parameter is passed by value (or VAL for compatibility with HiSoft BASIC 1 on the Amiga).

It is possible that the name of your external routine will clash with a symbol in the BASIC run-time system. None of the BASIC routines start with an underscore character so we recommend their use on your external names to avoid possible clashes.

The use of such a DECLARE statement will automatically produce linkable code without the need for a compiler option. Compiling a linkable program to memory is permitted to reduce development time but the program will not execute.

Calling C Functians

C and assembler functions are called in a very similar way to the way standard BASIC sub-programs are called.

If you are using C, call the function or sub-program in the same way as you would in C. Make sure that the types of the parameters in the BASIC DECLARE statement match the sizes of the parameters in the C code (taking particular care with integer sizes). The parameters should be in the same order in both languages.

If a parameter is a pointer and you normally use the C & operator when calling the function, omit the VAL keyword in the parameter list. The address of the BASIC variable will then be passed to the C code.

Calling Assembly Language Functians

For assembly language, any parameters are coerced to the appropriate type and pushed on the machine stack in reverse order (i.e. C order). Registers A3-A6 must be preserved and any return value should be in D0 (or D0 and D1 if a double, D0=high longword). A string return value should be in D0 and be a pointer to a null-terminated string.

You will need to ensure that your routine 'looks like' a C function. This involves reading parameters from the stack and using an RTS to return. You must leave the parameters on the stack. The code should be assembled to linkable code and the necessary routines exported using XDEF. We recommend that you use the ALIAS facility in the DECLARE statement; otherwise you must use case sensitive code and ensure that the names you export are lower case and start with an underscore.

Parameters

If numeric parameters are passed by value then their value (16-, 32- or 64-bits) is pushed on the stack. Double-precision parameters are passed in HiSoft BASIC 2 order as required by Lattice C; not in the same order as when using BASIC library.

If variable parameters are passed then the address of the variable is pushed.

Strings and arrays are passed as the address of their descriptor. The descriptor format is private and subject to change so utility routines are provided to convert them into a more useful form.

Linking

You should end up with a linkable file from the BASIC compiler and a linkable file from the C compiler or assembler. They should be linked together using Clink as supplied with DevpacST3 and Lattice C. You may also need to specify C compiler libraries if your C functions have referred to any.

With Lattice C 5, you should use the compiler options:

```
-b0 -r0 -v -w
```

which forces 32-bit variable references, 32-bit code and disables stack checking. If when you link there are undefined symbols this normally means your C is calling on a library routine. You will then have to specify the required C library when you link again, but take care that the library code does not assume any register values (e.g. for base-relative globals) or initialisation code (e.g. the Unix file system).

C-callable Utility Rautines

All utility routines may be called from assembly-language but only a few may be called from C, due to register requirements. The C-callable routines can be found in the file hbcufil.o on disk 2 which should be linked with your other code. You must generate stand-alone code to be able to use these routines.

```
long getbasicstr(d,&length)
long d; long length;
```


This should be passed a string descriptor address and the address of where the length should be stored (note that strings may be >64k). The return result is the address of the string which will *not* be null-terminated and you are *not* allowed to write to the string area.

```
long getbasicarray(d,dims,&length)
long d; short dims; long length;
```

This should be passed an array descriptor, the expected number of dimensions and the address of where the length should be stored. The return result is the address of the start of the array contents, guaranteed to be even. The length will be the total length in bytes taken up by the array elements. You are allowed to write to the array area.

Re-Entrant Cade

If you wish a compiled program to be made resident for use under the editor then it is your responsibility for your external routines to follow the necessary rules. We've done our bit...

Accessing BASIC glabal variables fram assembly

Using the Export Variable names option from the Advanced sub-dialog box in the Compile options box (or via the ! option) the names of your global variables will be exported as absolute symbols so that you can access them via the global register. As the BASIC variable terminators (%&!#$) are not allowed as parts of normal assembly language names, the terminators are changed to I, L, F, D and S respectively. The names are prefixed with _ for normal variable and @ for arrays. The variable names are forced to upper case. Conversely sub-program and function names are forced to lower case.

Here are some BASIC names are the corresponding name to use in assembly language:

i%	_II
fred&	_FREDL
mary!	_MARYF
john%()	@JOHNI
MARY!()	@MARYF

Linked Examples

Here is an artificially simple example of the process, starting with the BASIC program which uses an external function to compare two short integers:

```
DECLARE FUNCTION cequal% CDECL (VAL p1%,VAL p2%)
PRINT cequal%(1,2),cequal%(10,10)
```

Now the C function:

```
short cequal(a,b)
short a,b
{
return (a==b)
}
```

and the equivalent (Devpac ST 3/DevpacTT) assembly-language:

```
   opt   lattice
   xdef  _cequal
_cequal move.w  4(sp),d0
   cmp.w   6(sp),d0
   seq   d0
   ext.w   d0
   rts
```

A library is a collection of one or more assembler routines; the exact format of libraries is discussed below. When a library is finished, it is added to HBASIC.LIB using the BUILDLIB program supplied. From there on, your assembly routine can be accessed directly from BASIC by name.

How to write a Library

A library source does not look much different from that of an ordinary assembly language program. There are several additions which are necessary so that the compiler knows what a routine is called, how many parameters of which type are required and if it is a function or subprogram. In the LIBS folder on your master disks there is a file called LIBDEMO.S. This is an example of the format to use when writing a library. Study this example carefully before writing your own libraries.

DevpacST, version 1.2 and higher, is required to write libraries. You must specify OPT L+,C+ to produce a linkable file with case sensitive labels, or re-install uses these as your default options or on the command line.

A library's source code must conform to a defined format in order for BUILDLIB to be able to incorporate your library into HBASIC.LIB. Failure to conform will not normally be noticed by the assembler but will be reported, sometimes esoterically, by BUILDLIB.

The beginning of every library source has to have the definitions of the routines it contains. The definition commands are defined as macros in the header file LIBRARY.H. This file should be INCLUDEd into the source.

```
   INCLUDE    LIBRARY.H
```


This imports various constants and all the required macro definitions. After this you should define the name of your library; this is the name by which the library will be known to BASIC and need not be the same as its filename. The case of the name is irrelevant e.g.

```
   library    STUFF
```

Following this, the external references must be specified, e.g.

```
   XREF     get_string
   XREF     get_array
   XREF     make_string
   XREF.L   gl_scratch
```

These external references are the routines in the BASIC runtime system that your library must call to access arrays and strings and to return strings; note that they are case-sensitive. Constants to be indexed off register A5 are imported using XREF.L.

The names of the routines in your library must follow the external references as external definitions so that BUILDLIB and the compiler can reference them, e.g.

```
   XDEF     setbit
   XDEF     getbit
   XDEF     straint
   XDEF     baint
   XDEF     nullterm
```

When referring to these from BASIC, the case of the names is not important. It is however vitally important to remember the sequence in which you specified the names of your routines.

The next lines define the type of routine (subprogram or function), what types of parameters it takes and how many of them, and what type of value is returned (if any).

```
   subdef     int,vlng          setbit
   fn_int     int,lng           getbit
   subdef     str,aint,lng      straint
   subdef     aint,aint,lng     baint
   subdef     vstr              nullterm
```

The reason it is so vital that you remember the sequence of the XDEF's is because the routine definitions have to be in exactly the same order and there must be the same number.

We have created a simple macro-language to cope with the many types of routines and parameters.

Type	*Meaning*
`subdef`	This specifies a subprogram, i.e. not a function.
`fn_int`	This specifies a function that returns a 16-bit signed integer.
`fn_lng`	This specifies a function that returns a 32-bit signed integer.
`fn_sng`	This specifies a function that returns a single-precision floating-point number in the Motorola FFP format.
`fn_dbl`	This specifies a function that returns a double-precision floating point number in the IEEE format.

There are 15 different types of parameters that can be passed to an assembly language routine. They are:

Type	*Meaning*
`int`	a 16-bit signed integer value
`lng`	a 32-bit signed long integer value
`sng`	a 32-bit FFP single-precision value
`dbl`	a 64-bit IEEE double-precision value
`str`	a string value
`aint`	an array of ints
`alng`	an array of lngs
`asng`	an array of sngs
`adbl`	an array of dbls
`astr`	an array of strings
`vint`	an int-variable
`vlng`	a lng-variable
`vsng`	a sng-variable
`vdbl`	a dbl-variable
`vstr`	a string-variable

The first 5 types pass values directly while the last five pass pointers to variables like VAR parameters in Pascal. It is possible to pass a variable as a value parameter; it is *not* possible to pass a value parameter as a variable parameter.

There is also a library command called `option`. This has the same effect as `REM $OPTION` in BASIC and takes the option letters as a parameter.

```
option 'UV'
```

lets labels containing underscores be valid and forces variable checks. `option` macro calls must occur *after* all sub and fns have been exported, and *before* `libstart`.

When all of the routine definitions are finished, you must tell `BUILDLIB` that your code follows. You do this by specifying:

```
libstart
```

The Actual Code

After `libstart`, your code follows. There are two restrictions on the code you write for libraries:

- It must be completely position-independent. If you have Gen version 2 or above, you can specify `OPT P+` to force checks for position independent code.
- Imported runtimes and globals cannot be referenced as part of expressions, so for example

  ```
  clr.b   gl_scratch+10(a5)
  ```

  is not allowed.

A library routine must preserve registers A3-A6. Register A5 must be its normal value when any runtime routines are called.

Parameters are passed to the library routines via the stack in *reverse order*. Value parameters can be found directly on the stack, variable parameters are passed as pointers. Arrays and strings are passed to the library in the form of *descriptors*.

For example, if `vlng,aint,int` are passed to a routine, they will appear in reverse order on the stack; it would look like this:

Where	*Item*
`(SP).L`	the return address
`4(SP).W`	the INT value
`6(SP).L`	the array descriptor
`10(SP).L`	the pointer to the long integer variable

The int's value can be used directly:

```
MOVE.W  4(SP),D3
```

To get at the long variable is easy as well:

```
MOVE.L  10(SP),A0  the pointer
MOVE.L  (A0),D0    the actual value
```

and when you are ready to place the long back from D0 provided you have not altered A0, then

```
MOVE.L  D0,(A0)
```

will do just that.

Accessing arrays and strings is a bit more difficult. There are three subroutines in the BASIC runtimes provided just for this purpose: get_array, get_string, and make_string as described above.

gl_scratch

This is the only area of the runtime globals that a library may use; it is 128 bytes long. gl_scratch is referenced off register A5, and whose offset can be imported using

```
XREF.L  gl_scratch
```

Register A5 is defined in LIBRARY.H by a register equate as global. If your routine needs more memory, you will have to use stack space. *Under no circumstance* should you use any part of the heap!

Don't forget that strings in HiSoft BASIC can be larger than 64k, thus length parameters are always long in size.

To get the aint passed in the example, you must do the following:

```
MOVE.L  6(SP),A0
MOVEQ.L #1,D0    check if a single dimensional array
BSR     get_array
```

A2 now contains the address of the first element of the array, D4.L contains the total length of the array.

If an array has more than one dimension, the dimensions are arranged in a linear fashion. For example, Array(0,0) is the first, then comes Array(0,1) until Array(0,end), then comes Array(1,0) etc.

Strings and Things

The next example, nullterm, shows the use of get_string, make_string, and gl_scratch. Since libraries do not support a function that returns a string, a different way is used to return strings. The example below takes a string variable, copies it into gl_scratch, null-terminates it and returns the string to the variable.

```
nullterm
            MOVE.L      4(SP),A0        get the descriptor
            BSR         get_string
            CMP.L       #128,D4         check for size
            BLT.S       OKSiz
            MOVEQ       #127,D4         reduce size to fit
OKSiz       LEA         gl_scratch(global),A0
            MOVEA.L     A0,A2           save address of copy

            MOVE.L      D4,D5           save string length
            SUBQ.W      #1,D4           subtract 1 for DBF
Loop        MOVE.B      (A1)+,(A0)+     copy string
            DBF         D4,Loop

            MOVEA.L     A2,A1           get the address back
            MOVE.L      D5,D4           get the length back
            CLR.B       0(A1,D4.L)      null terminate
string
            ADDQ.W      #1,D4           a byte was added
            MOVE.L      4(SP),A0        the target
descriptor
            BRA         make_string     return the string
and
*                                       then back to BASIC
```

Returning values from Functions

When a function returns a value to BASIC, it does so by putting the value in the register named tos (which is actually register D7). This applies to fn_ints, fn_lngs, and fn_sngs. This looks like:

```
MOVE.W  D0,tos  returns a short integer
MOVE.L  D0,tos  returns 32 bits
```

When returning a 64-bit double, the register tos2 (actually D6) is used in addition to tos. The high 32-bits (exponent, sign and some of the mantissa) go into tos, while the low 32-bits of the mantissa go into tos2.

Library Format Summary

To summarise, the basic format of library source code is:

```
        opt         L+,C+           linkable, case
dependent
        include     LIBRARY.H

        library     library_name            defines name
        XREF        runtime1,runtime2       runtimes needed
        XREF.L      global1,global2         globals needed

        XDEF        mysub1
        XDEF        mysub2          a list of exports
        XDEF        myfn3

        subdef      mysub1
        subdef      mysub2
        fn_int      myfn3           matched list for BASIC

        option      'vun'           (optional)

        libstart

    your code here
```

You source file should be assembled to a .BIN file, then linked into the BASIC library by running BUILDLIB.

Using BUILDLIB

BUILDLIB is used to add user libraries to HBASIC.LIB, the compiler's library. The user library file must have the .BIN extension, as it is in linkable format.

BUILDLIB is a .TTP file, i.e. it takes a command line. On this command line should be listed the names of the files to be added to HBASIC.LIB, without their .BIN extensions specified. If no filenames are given, HBASIC.LIB will consist of only the standard runtimes.

BUILDLIB expects to find the HBASLIB.BIN file in the current directory; this file contains the BASIC runtimes. It creates the file HBASIC.LIB in the current directory. If you are using the desktop you will need to copy BUILDLIB .TTP to the same directory as the the libraries.

There are a few options that can be used with BUILDLIB. These should be at the start of the command line, prefaced by a - sign.

T Produce HBASICTT.LIB rather than HBASIC.TTP for use with the stand-alone compiler.

Z Don't wait for a key on termination

Q Produce the standard library with gemdos, bios, xbios,gemvdi, gemaes and menu. This command line and may not be followed or preceded by additional file names.

L List progress. This displays what BUILDLIB is doing as it does it, enabling you find which library is causing an error.

It can be easier to find symbol errors (e.g. undefined symbol) by using LinkST (supplied with DevpacST and Lattice C) to link HBASIC.BIN and your library. Any executable file produced by the linker should be deleted as it is not executable.

For example, double-clicking on BUILDLIB.TTP then entering

```
-Q STESOUND
```

will produce a full version of library with the STESOUND library in addition.

```
-L DEMO TEST
```

will cause the libraries contained in DEMO.BIN and TEST.BIN to be added to the runtimes from HBASLIB.BIN in HBASIC.LIB; the -L option dumps the narrative on the screen.

```
-ZT GEMDOS BIOS XBIOS
```

will produce a library for the TT with just the low-level parts of the operating system.

Note that if you run BUILDLIB from within the HiSoft BASIC editor using Run Other or the Tools menu, the new library created will not be used by programs you compile until you leave the editor and re-enter it. This is because the editor reads HBASIC.LIB into memory when it starts up and won't notice if it changes it in the meantime.

STESOUND library

This library uses the STE sound hardware which is also available on the TT. Before using this library you should check that the appropriate hardware is present using:

```
IF (GETCOOKIE("_SND") AND 2) = 0 THEN
PRINT "Sorry this program requires DMA SOUND hardware"
STOP -1
```

SUB DMAcontrol(BYVAL newvalue%)

This sets the STE sound hardware's control register. The appropriate values are:

0	Disable DMA sound
1	Do sound once
3	Do sound repeatedly

SUB DMAsound(BYVAL startadr&, BYVAL endadr&,BYVAL mode%)

This sets the start and end addresses of the sample address for the DMA sound hardware together with the sound mode. The `mode%` gives the sample rate (see the table below) and also whether mono or stereo is to be used. Add 128 in the values in the table for mono.

0	6258Hz
1	12517Hz
2	25033Hz
3	50066Hz

SUB MWout(BYVAL mask%,BYVAL data%)

Writes the values `mask%` and `data%` to the STE MICROWIRE interface. The full generality of this is not used, but it can be used to set the volume/tone and mixing of the STE DMA sound at present. This command issues the command immediately but waits for the command to be complete before returning.

SUB MasterVolume(BYVAL db)

This sets the DMA sound hardware's master volume to be `db` decibels. `db` should be between -80 and 0; the hardware supports this in 2 `db` steps.

SUB LeftVolume(BYVAL db)

This sets the DMA sound hardware's left volume to be `db` decibels. `db` should be between -40 and 0; the hardware supports this in 2 `db` steps.

SUB RightVolume(BYVAL db)

Sets the DMA sound hardware's right volume to be `db` decibels. `db` should be between -40 and 0; the hardware supports this in 2 `db` steps.

SUB Treble(BYVAL db)

This sets the DMA sound hardware's treble control to be `db` decibels. `db` should be between -12 and +12; the hardware supports this in 2 `db` steps and 0 is flat.

SUB Bass(BYVAL db)

This sets the DMA sound hardware's bass control to be `db` decibels. `db` should be between -12 and +12; the hardware supports this in 2 `db` steps and 0 is flat.

SUB SetMix(BYVAL mixvalue)

This controls the DMA Sound hardware's mixing with the standard ST hardware sound. The following values of `mixvalue` are supported:

0	-12 db
1	Mix
2	Don't mix

Appendix G
Desk Accessories

HiSoft BASIC can compile programs into a special form allowing the creating of desk accessories, usually reserved for languages such as C or Pascal. However HiSoft BASIC 2 will let you write desk accessories with very few explicit AES or VDI calls or even none at all when using the HiSoft GEM Toolbox (HGT). However when you use these short-cuts that HiSoft BASIC provides your program won't necessarily be able to cope with resolution changes or windows that are left open when another program terminates. Please don't expect them to be!

When testing your desk accessories don't be surprised if you crash the machine, because of a bug in your program. If you are testing on an auto-booting hard disk make sure that you know the procedure for disabling this and starting from floppy.

Get Ready

Unlike previous versions of HiSoft BASIC there's no need to use an additional HBASIC.LIB file when compiling desk accessories.

Any program wishing to be compiled to desk accessory from should have the line

```
REM $OPTION Jxx
```

where `xx` is equivalent to the `Keep` size in Kilobytes. It is used to specify the whole workspace size of the desk accessory while it runs. This will change the extension of the compiled program to .ACC.

The minimum value allowed is 15k, while 20k is recommended for smaller programs. This may also be set using the DA Size option from the Advanced box within the Compile dialog box. If you use this method ensure that you are using a different HISOFTED.INF file from the one that use for normal programs, perhaps by using a different directory for them.

Attempting to compile to memory will produce the message `program buffer full`.

Commands to use

Here are some routines that you will find useful when programming desk accessories.

```
FUNCTION menu_register%
    (BYVAL id%,BYVAL name$);
```

This GEMAES library function should be called early in the initialisation of the program and registers the accessory on the `Desk` menu. *`id%`* is the applications id, which can be found using the expression

```
PEEKW(PEEKL(GB+4)+4)
```

and *`name$`* is the name that appears in the Desk menu, normally starting with two spaces and no longer than 20 characters. The result of the function is the menu item identifier, from 0 to 5, or -1 if there is no room on the menu for the name.

The startup code for an accessory is quite different to that of a normal compiled .PRG file in that little initialisation is done, the only AES call made is `appl_init`.

Note that `da_before` and `da_after` that were used in HiSoft BASIC 1 are no longer present or required.

WINDOW SYSTEM

This command, which is built in to the standard BASIC library, opens the BASIC's window system virtual workstation and internal tables so that you can then use `PRINT` etc. This should be called after your program receives its open message.

WINDOW STOP

This closes the virtual workstation that was opened using `WINDOW SYSTEM`. You should always call this before your program returns to its event loop if you've used `WINDOW SYSTEM`.

Structure of a Desk Accessory

An accessory should have the structure of any event-driven GEM program, based on a main loop of `evnt_multi` or `evnt-mesag`. When the accessory is chosen from the `Desk` menu a message of type `AC_OPEN` (40, not 30 as often documented) will be received. The message `AC_CLOSE` (41, not 31) will be sent either when a GEM application terminates or the screen resolution is changed from the Desktop.

If you are using BASIC windows, then you use WINDOW SYSRTEM when you receive your AC_OPEN message

A compiled desk accessory is rather different to an ordinary program. For example an accessory can never *terminate* - if it does the machine will crash. Should a program stop for any reason, such as with a run-time error, the message will be printed at the bottom of the screen and a keypress awaited in the normal way, then the accessory will become effectively dead until the machine is re-booted.

Restrictions

Desk Accessories under TOS suffer from a major technical disadvantage; although they give every appearance of being a separate process, they actually can't allocate their own resources once the system has booted. Every time a desk accessory calls GEMDOS to obtain some memory, whether directly or indirectly it, the memory it receives is marked as owned by the current application - as such when that application terminates all that memory is de-allocated *before* the desk accessory is sent its `AC_CLOSE` message. This explains why desk accessories behave strangely is you leave their windows open when you quit an application..

There's also the further difficulty that when you change resolutions the memory that the program loaded at boot time (including any resource file that is loaded then) is removed without telling the desk accessory giving bombs when you change resolutions.

If you want to write a professional program that will survive resolution changes etc, you'll have to forgo many features that you've taken for granted in HiSoft BASIC and you'll need to call the operating system directly. If you can live with the problems that are described above then you'll find that you can actually use almost everything that you are used to.

The following commands should *not* be used within a desk accessory:

```
CHAIN, COMMAND$, RUN
```


Appendix H Program Profiling

Introduction

Profiling is a way to find out where your program is spending its time. This is particularly useful when a program is finished and you want to improve its performance.

There are two distinct steps involved in obtaining a program profile: firstly the program itself must be modified to create a file containing the required information, and run; next the profiling analysis program is run. It presents the profiling information in an easy to understand form.

Creating the Profile

Profiling a program is quite easy. All you must do is insert the line

```
rem $pron
```

where you would like profiling to start. If you want to stop profiling, at any particular line you must state:

```
rem $proff
```

Turning the profile off is not a necessity; on the other hand, a profile is of more value when it measures the time critical areas of a program as accurately as possible. When your program is compiled extra information is appended to the executable file which is used by the analysis program. When your program has finished running, a file containing the profile information is created on the current drive in the current directory with the extension .PRF.

You must compile to disk when using profiling.

The format of the .PRF file is straightforward: it is ASCII, the first line is the name of the executable being profiled and the remainder of the lines are of the form:

```
line_number,times_sampled
```

The first number is the line number in the source, the second is the number of times this line was found to be executing. If you use the `$include` meta-command, `line_number` will be the line number processed by the compiler, not necessarily the line number within an included file. Note that a comma separates the two numbers so that `INPUT#` can be used to access the data.

The extra information in the executable file tells the analysis program about any use of `$include` and where sub-programs and functions start and finish.

Analysing the Profile

Supplied with the compiler is a utility called PROFILE.TTP. This is the analysis program for profiling data. Run PROFILE.TTP by double-clicking on it from the desktop or by selecting it from the Tools menu in the editor. The parameter passed to the program is the name of the .PRF file (with or without extension) you wish to analyse. The profiler will automatically read the executable file - this must be in the place where it was created.

The profiler will then prompt you

```
How many lines?
```

Enter a number *n*; the analyser will show the *n* most frequently executed lines together with the percentage of time spent and the number of times the line was sampled, depending on the number you enter; the default (just hit `[Return]`) is the top 12 lines.

If you have used sub-programs and/or functions, Profile will prompt you again:

```
How many SUBs and FNs?
```

Again enter a number *n*; this will show the top *n* subprograms and functions; the default is 8.

Finally you will be asked:

```
Output to:
```

The default is the screen. You can also have the analysis data put into a text file; all you have to do is specify the name and extension of the file the information is to be written to.

If the output is going to the screen, you can use Ctrl-S and Ctrl-Q to pause and continue output.

Appendix I
TT Specifics

HiSoft BASIC takes full advantage of the Atari TT computer with support for the 68030 & 68881/2 processors; and also many library functions and sub-programs that allow you to access the new operating system supplied with the TT and MegaSTE computers.

TT version of the compiler

The ST version of the compiler runs on the TT and the editor can take advantage of the extended screen modes. It produces code that wil lrun of any machine in the ST/TT family.

The TT version of the compiler works in a similar way to the standard version except that it uses and generates 68030 instructions for faster and more compact code and generates inline code for the 68882 maths co-processor. The compiler itself and the code produced requires at least a 68020 and 68881 combination.

The code for the 68882 uses the full extended precision on chip and stores intermediate values on the maths stack as doubles regardless of whether they are stored in memory as singles or doubles. In general the TT version is more accurate than the software routines. Rather than storing singles as Motorola Fast Floating Point (FFP), IEEE singles are used as supported by the chip directly. These have different accuracy and precision to FFP numbers.

As such, you should not expect the same answers for numeric calculations on both compilers; if you are developing for both the ST and the TT you need to check the accuracy of your calculations on both machines.

We could have made the TT version produce results that are much closer to those produced by the ST version but the code produced would have run much slower as in line code could not have been produced. One floating point intensive benchmark runs 100 times faster with the TT version than it does on the ST version on the same machine.

For commerical developers who want their products to run on both machines, rather than providing an auto-sensing version of the system that would use software or hardware floating point according to the system we suggest that you provide two versions as we have done with HiSoft BASIC as this really lets the TT version take advantage of the new hardware.

TT Libraries

We have included the additional operating system calls that were introduced with TT TOS as part of the standard libraries. These cover access to the new video facilities, memory allocation etc.

As these routines are included in the standard libraries you can use them with the ST compiler; thus if you want one version of your program to run on both the ST and TT, you can still use the TT TOS facilities whenr running on a TT.

The STESOUND library also works on the TT.

TT Debugger

Unlike the other parts of the package MonSTB does not work properly on the TT because it assumes that it has a 68000 processor; the screen handling routines that write directly to screen RAM do not 'know' about the TT resolutions and so MonSTB can not be used with them.

Thus you must use MonTTB; in addition to the features described above you can also access the additional TT MMU and floating point registers and the disassembler will disassemble the floating point and additional 68030 instructions. Register FP0 is used by the compiler to store the current floating point intermediate result.

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HiSoft BASIC version 2 Technical Reference

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